DOE/NASA CONTRACTOR REPORT

DOE/NASA CR-161272

SOLAR ENERGY RETROFIT FOR CLARKSVILLE MIDDLE SCHOOL, CLARKSVILLE, INDIANA

Prepared by

Clarksville Community School Corporation
200 East Ettels Lane
Clarksville, Indiana 47130

Under Contract DOE EG-77-A-01-4076

Monitored by

National Aeronautics and Space Administration
George C. Marshall Space Flight Center, Alabama 35812

For the U. S. Department of Energy

U.S. Department of Energy

Solar Energy

TABLE OF CONTENTS

Solar Energy Retrofit for Clarksville Middle School
Clarksville, Indiana

James W. Galbreath
Max F. Spaulding

KEY WORK ABSTRACT

Application--heating.
System Type--hot water.
Collector Type--Flat plate liquid.
Collector Manufacturer--Solar Development Inc., West Palm Beach, Florida.
Collector Area--6520 square feet.
Storage Capacity--10,000 gallon steel tank.
Building Load--9.82 x 10^8 BTU/yr.
BTU's Produced--6.94 x 10^8 BTU/yr.
Building Owner--Clarksville Community School Corporation
Clarksville, Indiana
Architect/Designer--Walker, Applegate, Oakes, & Ritz, Inc.
New Albany, Indiana
Contractor--Witten Bros., Charlestown, Indiana

INTRODUCTION

Clarksville Middle School is located in Clarksville, Indiana which is directly across the Ohio River from Louisville, Kentucky. The building is a one story structure, constructed in 1967. It has non-load bearing masonry walls, steel columns and roof joist, gypsum and composition wood fiber roof decks, and concrete floor slab on grade.

The building is of the "compact" design with a large percentage of the classrooms and activities areas being interior spaces. The building is completely air conditioned.

The air conditioning is provided by a central chilled water system with classroom unit ventilators and large capacity air handling units in the large interior spaces. The heating is accomplished by electric resistance heaters located in the ventilators.

The existing chilled water system was designed to provide cooling of the academic areas of the building or the gymnasium, but not both simultaneously. A system of automatic control valves provides for switching the flow of chilled water to the academic zone or the gymnasium zone. The solar energy system is a heating only system for the existing gymnasiums. The system is utilizing the existing chilled water piping and chilled water coils in the air handling units.

A proposal was submitted to the Energy Research and Development Administration in October, 1976, in response to Program Opportunity Notice DSE 76-2. Following the successful completion of the technical evaluation, a cost pro-

posal was submitted in March, 1977, and a contract was signed in September, 1977. A construction contract was let in April, 1978, and the system began functioning in late October, 1978. It will be in full operation during the coming winter.

DESIGN PHILOSOPHY

Solar Energy System

The solar heating system is to provide heating for the two gymnasiums in the middle school building. The present level of energy consumption to heat these spaces compared to the rest of the school building is considerable. Compared to classrooms with their greater student density and lighting levels, the gymnasiums are consuming heat energy all through the heating season.

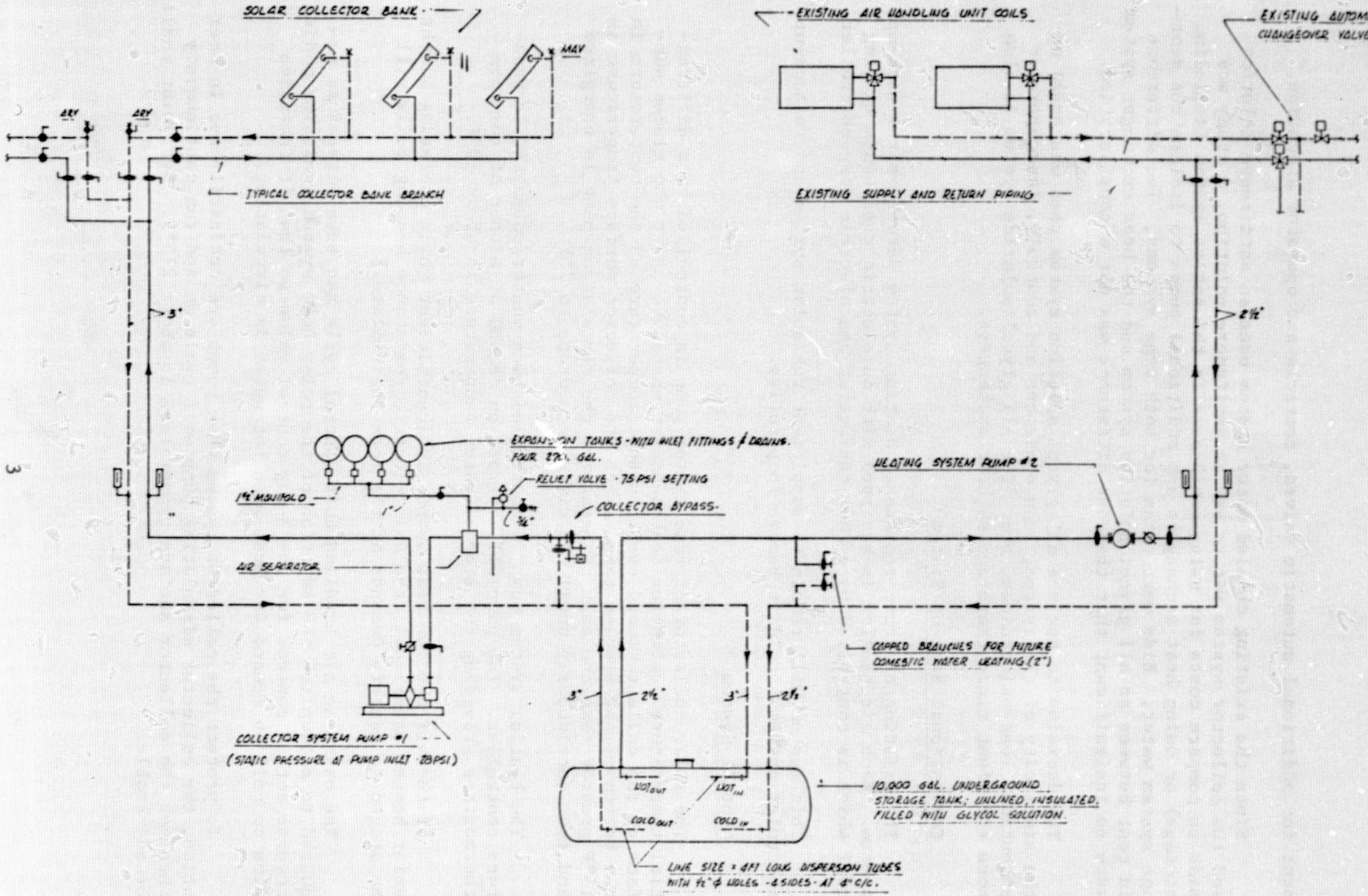
Flat plate, single glazed, selective coated solar collectors are installed on the roof of each gymnasium with the panel array facing due south. The collectors are tilted at 50°. A storage tank facility is installed below grade adjacent ot the school building. A piping system circulates water from the storage tank, through the collectors and return the heated water to the storage tank. The system is schematically illustrated in Figure 1 "Schematic Piping Diagram."

Large capacity air handling units are presently located in the gymnasiums. These units are equipped with chilled water coils and electric resistance heating coils. The chilled water coils and the associated chilled water piping system are being utilized for a hot water solar heating system. The existing chilled water system is piped in a manner such that the two gymnasiums are isolated from the rest of the building. In fact, if need be, the rest of the building can operate on cooling cycle (due to high interval gain) while the gymnasiums are on heating cycle.

As illustrate in Figure 1, a separate piping system is installed to circulate the solar heated water from the storage tank to the hot/chilled water coils and return the cooled water to the storage tank.

The pumps for the system are located in the existing basement mechanical equipment rooms. The existing gas fired domestic water heater is also located in a basement mechanical equipment room. Provisions have been made in the new solar equipment piping system so that in the future, a heat exchanger can be added for heating domestic water during periods that building space heating is not required.

The existing chilled water system in the building utilizes a water/ethylene glycol mixture to prevent freezing in a chilled water coil should an outdoor air damper not function and remain open when the electric heat is not energized. The collector piping system employs a glycol solution to avoid freeze-up in the collectors and piping. The antifreeze type system was selected rather than the drainback type system to avoid the require-



SCHEMATIC PIPING DIAGRAM

NO SCALE

ment for additional automatic valves, controls and operator attention.

Since the existing chilled water system uses an antifreeze solution and the collector system was to use an antifreeze solution, a study was made to compare costs for using antifreeze in the entire system (including storage) or using heat exchangers and additional pumps to isolate the storage system water. Bids were taken for both type systems. The difference in cost between an all glycol solution system and the heat exchanger system were so insignificant that the cost difference was not a consideration.

The decision to use the all glycol solution system then was based on the simplicity of the system, less equipment and controls, less operator attention, less maintenance, etc. The all glycol solution system is also more efficient since there are no heat exchangers.

Conventional Back-up System

The existing electric resistance heating system serves as the back-up system. Each air handler is equipped with an electric resistance heating coil which is controlled by a room thermostat and electric step controller.

This system will remain to supplement the solar system and to back-up the solar system should it become inoperative.

Control System

The solar collector/storage system pump is controlled by a differential temperature controller that senses temperature under the glazed surface of the collectors and compares that temperature to the temperature in the bottom of the storage tank. When the collector surface temperature is 15°F greater than the tank temperature, the circulating pump is energized and runs continuously until the difference drops to 7°F.

The heating system pump is controlled by a master/submaster temperature controller. The pump will operate on demand of either of the room thermostats providing the storage water temperature is above 80°F.

If the air handler heat output is insufficient while operating on the solar heated water coil, the unit electric resistance heating coils will be staged to satisfy demands of the room thermostats.

The existing air handling unit control cycle has been altered as required to accomplish the addition of the solar heat system including adding reverse acting control for the 3-way control value so that it increases flow to coil on demand for heat when hot water is circulating.

To protect the collector system when pumps are ordinarily not in operation, the collector circulating pump will cycle on and run continuously whenever the collector surface temperature is above 275°F. Set point shall be adjustable.

An alarm and pump cut-off system has been provided that will be activated upon loss of system pressure. Upon loss of system pressure, all pumps will immediately be de-energized and an alarm light on the control panel and an alarm siren will be activated. The alarm light remains on until the low pressure situation is corrected. An alarm siren silencing switch located in the control panel permits the bell to be silenced while the low pressure situation is corrected.

A collector bypass system is included that will prevent return water from the collectors from entering the storage tank until the return water temperature is equal to or greater than the temperature of the water stored in the top of the tank.

OPERATION OF THE SYSTEM

The system is operating properly. It has been efficient and without any major problems. Since the system is simple and automatic the time required in operation is minimal.

PROBLEMS ENCOUNTERED AND SOLUTIONS

The system encountered some minor control problems in its initial operation. The control in the bottom of the tank was sensing a false temperature due to heat conduction in the conduit. This problem was corrected and the controls operated correctly. Our biggest problem was one of meeting the time line and in the coordination of various agencies. Being a public supported institution it is necessary to receive clearances from our State Department of Public Instruction and the Administrative Building Counsel. These approvals could not be obtained until our final design review was completed. It was also impossible to go through the state required advertising and bidding process until all approvals were received. Thus, the project was slowed by the demands of coordinating state and federal requirements.

Once the project was let for bids, the cost had increased by thirty-one per cent (31%) or $66,158.00. This cost increase had to be financed locally. This financing requirement meant we had to go through another administrative process in order to obtained state approval for additional appropriation. This process consumed forty-five (45) days; however, the project was successfully initiated in April, 1978. No solution to coordinating the paper work is possible, it just takes patience and perseverance.

SUCCESSFUL COMPONENTS OR PROCESSES

The system is, however, somewhat unique in that it is a retrofit of a chilled water system that was not previously used for heating. This type application could possibly have a rather broad appeal in that there are any number of presently installed chilled water/electric re-

sistance heat systems.

COST

The cost of this project is $282,000.00. The Department of Energy is paying $129,505.00. The remaining balance is funded by the school corporation's cumulative building fund. The original estimate of cost was $215,842.00. The cost increased was attributed to three reasons: inflation, design review changes, and labor overhead.

Since our project cost was estimated in March, 1977, and negotiated in August, 1977, but actual bids were not received until April, 1978, the inflation rate during that period of time cost us $8,000.00. This estimate is conservative since the inflation rate in the construction industry was approximately one per cent (1%) per month.

Between the time of negotiations and the actual letting of the contract, several designs changes were made. Some of these changes were suggested by the Department of Energy while others were considered appropriate by our own architect/engineer. Our own specific design changes cost us approximately $26,000.00. Changes recommended by the Department of Energy amounted to approximately $6,000.00. It should be noted that the changes by the Department of Energy were only suggestions. When we asked them for additional money for their changes, we were informed that they were only recommendations and did not have to be made. However, for our system to function at an optimum level the changes were necessary and made at local expense.

Another problem we encountered with the finances was the amount of overhead and profit. It has been common procedure in our area that an estimate of fifteen per cent (15%) overhead and profit, would be appropriate; however, the low bidder used a figure of forty per cent (40%) overhead and eight per cent (8%) profit. This gave a total of forty-eight per cent (48%) for overhead and profit. The use of the forty-eight per cent (48%) caused our estimate to be off by $23,000.00.

LESSONS LEARNED

One of the most pronounced lessons learned was that the state of the art is continuously changing. When we originally started our project the type of collector on the market was inferior to the product that is presently available. It was fortunate that our project was slowed by the required paper work so we could change collectors and obtain a more efficient model.

Another lesson learned is that the bureaucratic structure of both state government and federal government is difficult to coordinate. Our original time lines and estimates of when the project could be started for construction and completed were very inaccurate. One cannot become

too impatience or the project will not proceed smoothly.

OTHER KEY ITEMS OF INTEREST

Our project is unique, in the fact, that up until this date no change order has been issued. As is customary if you can obtain only five per cent (5%) change orders, then your project is considered to be fortunate. At this time we have had no change orders, and I must credit our architect/ engineer, NASA and our state agencies for requiring us to take the time to plan carefully. I also complement Witten Brothers Construction Company for a thorough, neat and creditable job. They have shown great pride in their work and have taken the pains to do it right.

CLARKSVILLE MIDDLE SCHOOL

FIRST ESTIMATE OF SOLAR SYSTEM ENERGY SAVINGS

We have only two months experience with our Solar Heating System for tho two gymnasiums in our Middle School. However, this is enough to give us some indication of savings we might expect from its use. The data is only tentative. We need an entire heating season to get more reliable data.

Year, Months	KW Hr used-total	Estimated KW hr used for heat	Degree Days	KW hr per degree days	Dollars per degree day
1975, Oct-Dec	846,000	726,000	1437	505	$17.17
1976, Oct-Dec	923,000	803,000	2132	377	$12.81
1977, Oct-Dec	749,000	629,000	1702	369	$12.56
Average, pre-Solar Heating System, dollars per degree day					$14.18
1978 Nov-Dec	531,000	471,000	1500	314	$10.67
Degree day, pre-Solar Average cost minus Solar average costs = 14.18 - 10.67 =					$3.51

Average heating season of 4900 degree days times an average cost savings of $3.51 = $17,199 cost savings per heating season.

Total payback assuming no utility increases would be:,

Years = $\frac{\$282,000}{\$\ 17,199}$ = 16.4 years Our Payback = $\frac{\$152,000}{\$17,199}$ = 8.8 years

APPENDIX A

ACCEPTANCE TEST PLAN

9.0 ACCEPTANCE TEST

9.1 The Mechanical Contractor together with his Testing and Balancing Sub-Contractor and Temperature Control Sub-Contractor shall demonstrate to the Owner and Architect/Engineer that the solar heating system meets performance requirements.

9.2 Prior to the demonstration, the Mechanical Contractor shall have completed the Piping Systems Testing and Piping Systems Cleaning and Sterilizing specified in Articles 3.0 and 4.0 of Section 15D of this specification and the Storage Tank Testing specified in Article 7.0 of this Section.

9.3 Prior to the demonstration, the Testing and Balancing Sub-Contractor shall have completed the complete systems Testing, Adjusting and Balancing Procedures specified in Article 5.0 of Section 15D of this specification.

9.4 Prior to the demonstration, the Temperature Control Sub-Contractor shall have regulated and adjusted all devices provided under his contract as specified in paragraphs 2.3 and 2.4 of Section 15H of this specification.

9.5 Demonstration

a. Verify that pumps, valves, tank, collectors, specialties and controls are installed in manner specified and shown on contract drawings.

b. Demonstrate operation of system pumps. Verify that operation is relatively free of vibration, smooth operating, pumps are properly lubricated and developing required pressures.

c. Demonstrate that expansion tank(s) have proper air cushion, inlet and drain fittings properly installed.

d. Demonstrate operation of system pressure relief valve(s); manually trip valve(s) and automatically trip valve(s).

e. Demonstrate operation of check valves and/or triple duty valves. Flappers to operate free of flutter and to be non-slamming.

f. Demonstrate operation of make-up water connection back flow preventor.

g. Verify operation of all indicating thermometers and pressure gauges.

h. Demonstrate operation of pump motor control devices - disconnects, starters, relays, etc.

i. Demonstrate operation of differential temperature controller starting collector system pump(s).

j. Demonstrate operation of room temperature master/submaster temperature controllers starting heating system pump(s).

k. Demonstrate operation of room temperature master/submaster temperature controllers operating 3-way coil control valves.

l. Demonstrate operation of heating system pump low limit temperature control.

m. Demonstrate operation of second stage of control of room thermostats operating electric resistance heaters.

n. Demonstrate operation of low pressure alarm and pump cut-off system. Simulate low condition to activate system.

o. Demonstrate operation of collector excess temperature controller. Simulate elevated collector surface temperature to activate collector pump(s).

p. Demonstrate operation of collector bypass system (Alternate No. 2).

q. Verify that "As-Built Drawings" and "Operation and Maintenance Manuals" have been prepared and submitted in accordance with specification requirements.

WALKER APPLEGATE OAKES AND RITZ, EBY WALKER GALBREATH AND LEACH
ARCHITECTS AND ENGINEERS 138 EAST SPRING STREET POST OFFICE BOX 256 NEW ALBANY, INDIANA 47150 • (812) 945-6696

December 7, 1978

Mr. Jim Witten
Witten Bros., Inc.
P.O. Box 206
Charlestown, Indiana 47111

Re: Solar Energy Retrofit
Clarksville Middle School
Clarksville, Indiana
WAOR #776C

Dear Mr. Witten:

This is to follow-up on our meeting with Mr. Doug Westrope, DOE, at the subject project on December 5, 1978. The purpose of the meeting was to review the Acceptance Test as specified in Article 9.0 of Section 15F of the Project Manual.

Following is an item by item review of the Demonstration procedure outlined in paragraph 9.5 of the above referenced Article.

a. "controls" - the situation regarding the false temperature reading indicated by the tank bottom probe must be corrected.

b. ok

c. "air cushion" - tanks to each have same liquid level, also adjust static pressure to 28 psi at collector pump inlet.

d., e., f. - ok

g. "thermometers" - insulate necks; "pressure gauges" - check operation of gauge at collector pump inlet, seems to be reading different than gauge at discharge (at static condition).

h. ok

i. "differential temperature controller" - needs adjustment and fine tuning.

j., k., l., m., n., o. - ok.

p. "bypass system" - controller needs adjustment and fine tuning.

q. "As-Built Drawings" - submit as specified; "Manuals" - revise and resubmit.

Additional items that need attention are as follows:

1. Adjust air handling unit outdoor and return air dampers to 10% minimum outdoor air.

2. Complete pipe hanger installation on domestic water line on ceiling of Boys' Gym.

Please give these matters your early attention.

Very truly yours,

James W. Galbreath

baz

cc: Mr. Max Spaulding
Mr. Dick Rademaker

APPENDIX B

MAINTENANCE AND OPERATING INSTRUCTIONS

Witten Bros., Inc.

P. O. Box 206
Charlestown, Indiana 47111

Mechanical Contractors

Phone 256-3393

CLARKSVILLE MIDDLE SCHOOL
SOLAR HEAT

MAINTENANCE AND OPERATING
INSTRUCTIONS

FOR WARRANTY SERVICE CALL
256-3393
ALL WORK IS COVERED FOR ONE YEAR

FOR EQUIPMENT SERVICE CALL
RADEMAKER AND ASSOCIATES 267-9636

CLARKSVILLE MIDDLE SCHOOL SOLAR HEAT

MAINTENANCE AND OPERATING INSTRUCTIONS

Witten Bros., Inc.
P. O. Box 206
Charlestown, Indiana 47111
Mechanical Contractors
Phone 256-3393

CLARKSVILLE MIDDLE SCHOOL
SOLAR HEAT

STARTUP INSTRUCTIONS

NOTE: Under normal operation the system should never be shut down.

1. Place the solar heat system switch in the "Auto" position.
2. Note water temperatures at collectors and at top of storage tank.
3. If the collector's water temperature exceeds the storage tank water temperature by approximately 15° the collector pump should start, and should run until the storage tank water temperature is within approximately 5° of the collector water temperature.
4. Set temperature controls in the boys and girls activity rooms to desired temperature. System pump will start and circulate heated solution to coils.

SHUTDOWN PROCEDURES

The Solar Heating System is designed to operate year round and does not require any shutdown instructions under normal circumtances. If a major piping break was to occur and/or a leak that could not be isolated the on and off switch located inside of the temperature control panel will shut the system down.

NOTE: Under normal operation the system should never be shutdown.

Clarksville Middle School Solar Energy Retrofit
Control System Operating Instructions

The"On-off" solar heating system switch, located inside the control panel, will energize the entire solar heating control system. Under normal operating conditions this switch should be left in the "Auto" position.

The solar collector's circulating pump and the system heating pump have "Auto-off-hand" switches at their respective starters. Under normal operating conditions the switches should be left in the "Auto" position.

An alarm silence switch is located on the control panel door. Under normal operating conditions this switch should be left in the "Auto" position. In event that the alarm horn is energized, indicating a loss of system pressure and a possible leaking condition, the switch should be placed in the "Silence" position until the alarm condition is corrected.

The solar heating control system is designed to operate year round and does not require any specific "Turn-On" or "Turn-off" functions. The temperature indicating meters located on the control panel door, should be read periodically and if any abnormal temperatures seem to exist the proper people should be contacted for repair.

A three-way valve will bypass glycol around the tank until the collector glycol is hotter than the tank glycol. This valve is controlled by a differential control with sensors in the glycol leaving collectors and in tank glycol. No adjustment is required.

Witten Bros., Inc.
P O Box 206
Charlestown, Indiana 47111
Mechanical Contractors
Phone 256-3393

CLARKSVILLE MIDDLE SCHOOL
SOLAR HEAT

MAINTENANCE INSTRUCTIONS

The Solar Heating System is designed to require a minimum of maintenance. Tabs E, F and G of this manual contain detailed parts and maintenance instructions.

Pumps must be lubricated in accordance with the lubrication instructions under Tab F.

Temperature controls do not require any periodic maintenance. If temperature controls fail, a qualified individual should check out the cause of failure.

The potable water system to the hose bibs on the roof must be drained down at any time there is danger of freezing.

NOTE: Under normal operation the system should never be shut down.

CLARKSVILLE MIDDLE SCHOOL

CLARKSVILLE, INDIANA

Balancing Data

BALANCING DATA
FOR
CLARKSVILLE MIDDLE SCHOOL

Performed by

RADEMAKER CORPORATION

Technicians: Dennis Soeder and Ralph Stasie
under supervision of R. W. Rademaker, P.E.

Final data was taken on 12-2-78 under situation with cloudy skies and glycol/water temperature approximately 100° while in recirculating position.

All circuit setter readings were corrected for 50% glycol at the temperature of circulating liquid.

Overlay print is attached to identify exact location of circuit setters and rating per design versus actual flow as indicated.

Actual flow exceeds rated flow by slightly more than 10%, which very closely totals to the required volume to be handled by pump P-1 per pump schedule.

CLARKSVILLE MIDDLE SCHOOL

Balancing Report & Supplementary Information

PUMP DATA PER DESIGN

P-1
Taco No. BB-3006, Base Mount, with 5.4" Impeller rated for 189 GPM at 101' head, 3450 RPM, 7.5 BHP, Max. static pressure 125 psi.

P-2
Taco No. 1636C, In-Line, with 6.25" Impeller, rated for 70 GPM at 33' head, 1750 RPM, 1 BHP, Max. static pressure 175 psi.

MOTOR DATA

Marathon - 213-T frame, Serial No. 1418573, rated amps 13.5 @ 460 V., 10 HP, 3470 RPM.

GE - 56 frame, Model No. 5K45PD1133H, rated amps 2.8 @ 460 V., 1-1/2 HP, 1725 RPM

ACTUAL PUMP DATA

P-1
Actual measured ΔP = 43 psi
43 x 2.2 = 94.6 ft.

Amps = 10.0 @ 466 volts
RPM = 3470
Calculated BHP = 7.41

P-2
Actual measured ΔP = 14 psi
14 x 2.2 = 30.8 ft.

Amps = 2.8 @ 466 volts
RPM = 1725
Calculated BHP = 1-1/2

TACO

BASE MOUNTED and CLOSE COUPLED PUMPS

3006 1750-3450 RPM

EFFECTIVE: JULY 31, 1974 SUPERSEDES SD 300-3-16 dated 10/31/72

SD 300-3-16

JOB:

DATE SUBMITTED: BY:

Location	Model No.	Pumpsize	Impeller Size	GPM	Head	Voltage	Phase

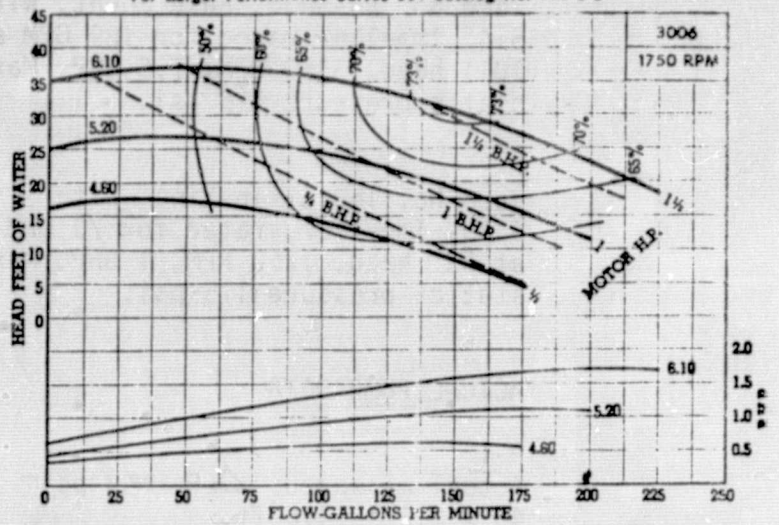
SPECIFICATIONS

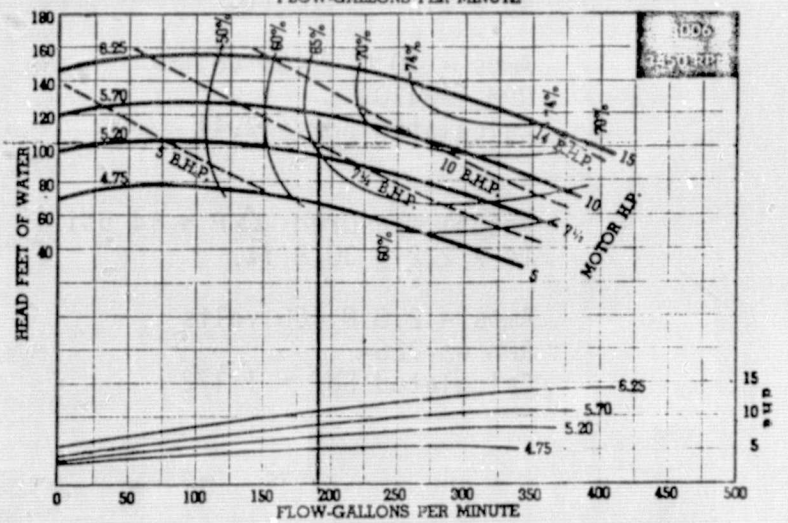
	STANDARD CONSTRUCTION			OPTIONS
Description	Ball Bearing	Sleeve Bearing	Close Coupled	
Frame	Ball Bearing	Sleeve Brng.	———	———
Coupler	4 Way Flex	4 Way Flex	———	———
Baseplate	Structural Steel	Structural Steel	———	———
Shaft-Pump	Alloy Stl	Alloy Stl	Alloy Stl (Mtr. Shaft)	☐ Stainless* Steel
Mech. Seal	Permalife 1 (250F)	Permalife 1 (250F)	Permalife 1 (250F)	Permalite 2* ☐ (300F)
Stuffing Box	250F	———	250F	☐ Yes
Bronze Gland w/ S.S. Studs & Nuts	with Stuff Box	with Stuff Box	with Stuff Box	———
Shaft Sleeve	Cupro Nickle	Cupro Nickle	Cupro Nickle	☐ St. Steel w/Stuff Box
Impeller	Cast Iron	Cast Iron	Cast Iron	☐ Cast Brz.
Special Imp. Cut	———	———	———	☐ Yes .....
Motor, O.D.P. 60 cycle, 3 phase 230/460	☐ 1750 BB ☐ 3450 BB	1750 SB	☐ 1750 BB ☐ 3450 BB	☐
Purocell Filter	———	———	———	☐ YES*
Coupler Guard	———	———	———	☐ YES*
Brz. Const.	———	———	———	☐ YES*
Comp. Flanges ASA	———	———	———	☐ YES*
Bronze Wear Ring	———	———	———	☐ YES*
Working Pressure Test Pressure	175PSI** 250 PSI	175PSI** 250 PSI	175PSI** 250 PSI	——— ———

*Not Included in Standard Cost

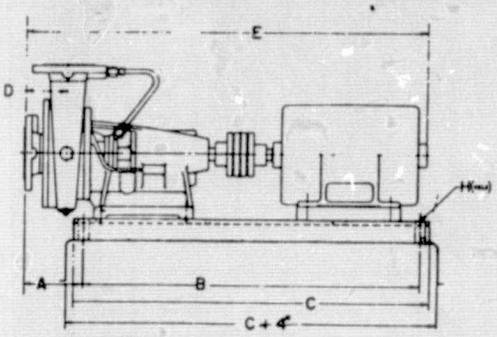
**In accordance with ASA B16.1

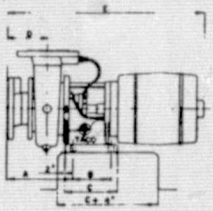
For Larger Performance Curves See Catalog No. 300-3-1

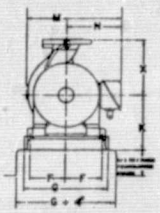




SIZES AND DIMENSIONS







	Product No.	Motor RPM	Motor HP	Suction & Dis. Conn.	G	C	K	F	B	J	H	A	D	X	N	M	E
Base Mounted	SB 3006 BB 3006	1750	½ 1 1½	3	12	27¾	8¼	4¾	26⅞₂	3	⅝	7⅜	4¾	7½	6¹⁵⁄₁₆	12¹⁵⁄₁₆	34⅜
	BB3006	3450	5 7½ 10 15	3	12 12 13 13	27¾ 27¾ 35⅜ 35⅜	8¼ 8¼ 9¼ 9¼	4¾ 4¾ 5¼ 5¼	26⅞₂ 26⅞₂ 33⅞ 33⅞	3 3 4 4	⅝	7⅜	4¾	7½	7³³⁄₃₂ 7³³⁄₃₂ 8½ 8½	13³³⁄₃₂ 13³³⁄₃₂ 15 15	35 36 42 42
CLOSED COUPLED	CC3006	1750	½ 1 1½	3	10	6¼	5¼	4¼	4½	1	⅝	7¹¹⁄₁₆	4¾	7½	6	11⅞ 11³⁷⁄₆₄ 11³⁷⁄₆₄	21¹⁵⁄₁₆ 21¹⁵⁄₁₆ 22¹⁵⁄₁₆
	CC3006	3450	5 7½ 10 15	3	12	6¼	6½	5¼	4½	1	⅝	7¹¹⁄₁₆	4¾	7½	7 7 8¹³⁄₁₆ 8¹³⁄₁₆	12⅝ 12⅝ 14⅜ 14⅜	23¼ 24¾ 26¹⁵⁄₁₆ 27⅜

ORIGINAL PAGE IS OF POOR QUALITY

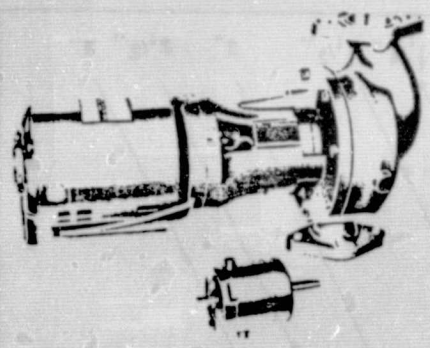
TACO

NUMBER
SD 300-1-12

STANDARD 1600 SERIES CARTRIDGE TYPE IN-LINE PUMPS

EFFECTIVE: APRIL 1, 1974
SUPERSEDES: NEW

NOTE: TACO Submittal Data Sheets SD 300-1-5 SD 300-1-8 SD 300-1-9 SD 300-1-10 are OBSOLETE and are NO LONGER VALID.



JOB:

Date Submitted: By:

LOCATION	PUMP SIZE	GPM	HEAD	PHASE

SPECIFICATIONS:

MOTORS
1750 RPM, Three Phase 200V or 230/460V 60C Sleeve Bearing Motors. Also available in Single Phase with overload protection except 3 HP.

BODY
Cast Iron with flanged in-line connections. Companion flanges are included

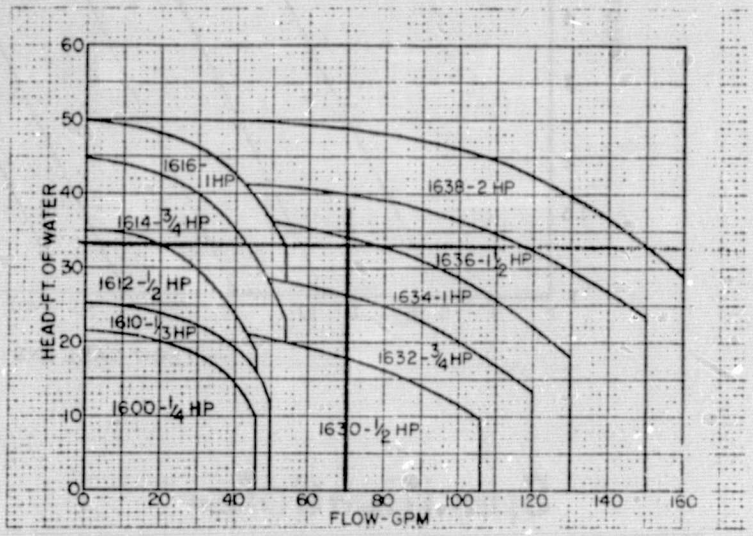
IMPELLER
Cast Bronze, Closed, Dynamically Balanced.

DRIVE COUPLING
Non-Metallic / Vibration Dampening

SHAFT
Stainless Steel with Cupro-Nickel Sleeve.

FRAME
Sleeve Bearing, Disc Type, Oil lubricated. REMOVABLE BEARING CARTRIDGE FITS ALL MODELS. Dip Stick to measure oil level.

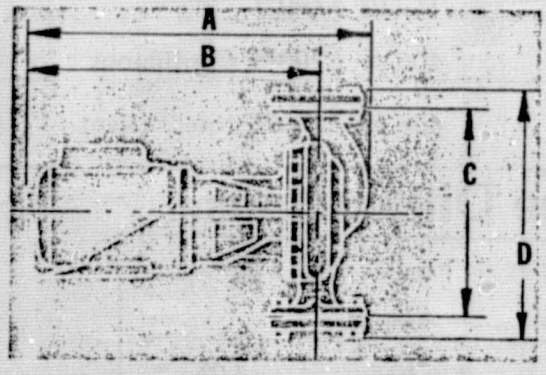
MECHANICAL SEAL
Standard–250°F Operating Temp.



WORKING PRESSURE
175 PSI... in accordance with ASA B16.1

NOTE: Flanges are tapped for gauges

SIZES & DIMENSIONS:



MODEL NO.	Flg. Size	MOTOR DATA			DIMENSIONS			
		HP	60 Hz 1 Ph.	60 Hz 3 Ph.	A	B	C	D
1600	1½	¼	115V	NOT AVAILABLE	19	16½	10¼	12⅞
1610		⅓	115V		19	16½	10¼	12⅞
1612		½	115/230	200 or 230/460	21	18½	13½	16⅛
1614		¾			21½	19	13½	16⅛
1616	2"	1			22	19	14½	17⅜
1630		½			21½	18	13½	16⅛
1632		¾			22	18½	13½	16⅛
1634		1			22½	19	13½	16⅛
1636		1½			24½	21	16½	19½
1638		2			26½	23	16½	19½

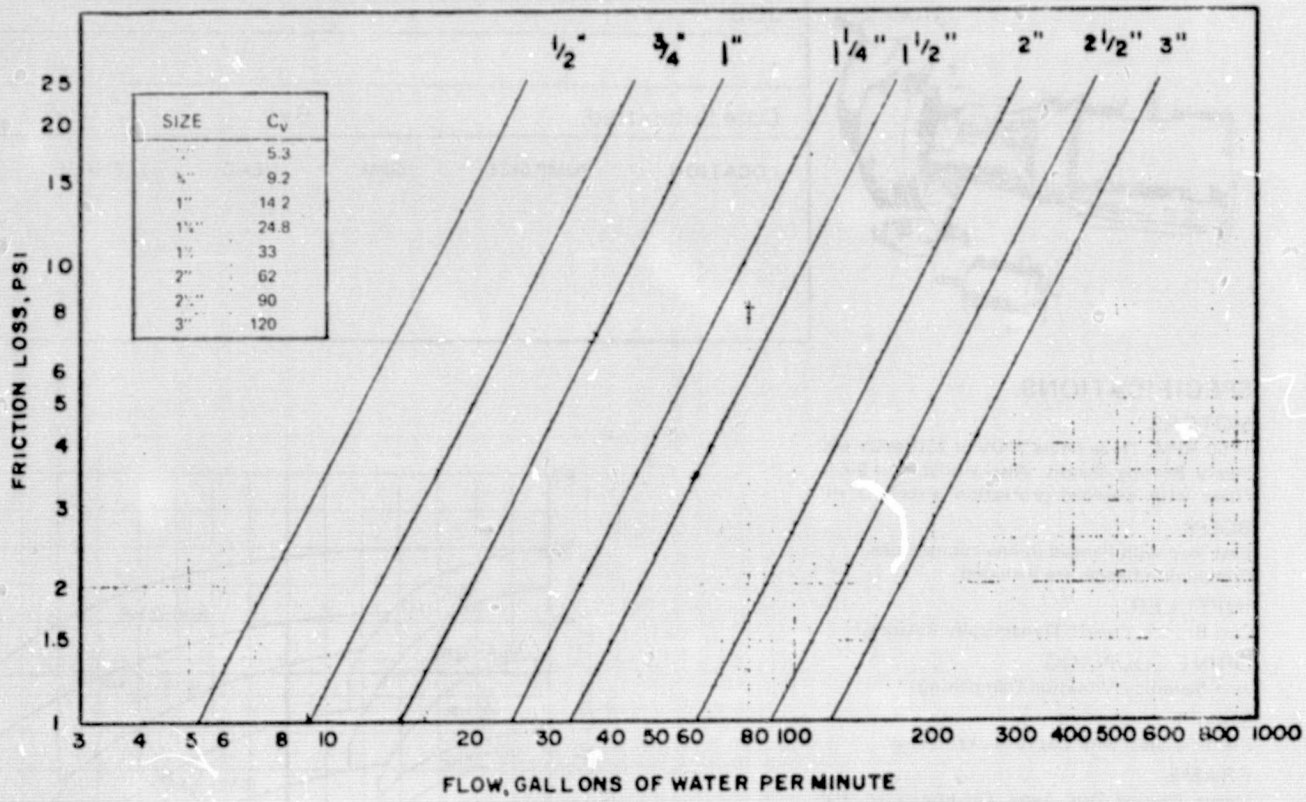
Taco Heaters of Canada, Ltd.
3090 Lenworth Drive
Mississauga, Ontario

Taco, Inc. 1160 Cranston Street, Cranston, Rhode Island 02920 U.S.A.

printed in U.S.A.

TACO CIRCUIT SETTER

Pressure Drop Curve – IN OPEN POSITION



Specifications

SIZES	½",¾",1",1¼",1½".2",2½",3"
BODY MATERIALS	BRONZE
TRIM MATERIALS	BRONZE
SEALS & SEATS	TFE
INDICATOR PLATE	ALUMINUM
PRESSURE / TEMPERATURE RATING [Circuit Setter]	175 psi / 250°F
PRESSURE / TEMPERATURE RATING [789 Differential Pressure Gauge]	400 psi / 200°F Continuous
PRESSURE / TEMPERATURE RATING [788 Differential Pressure Gauge]	400 psi / 240°F Intermittent

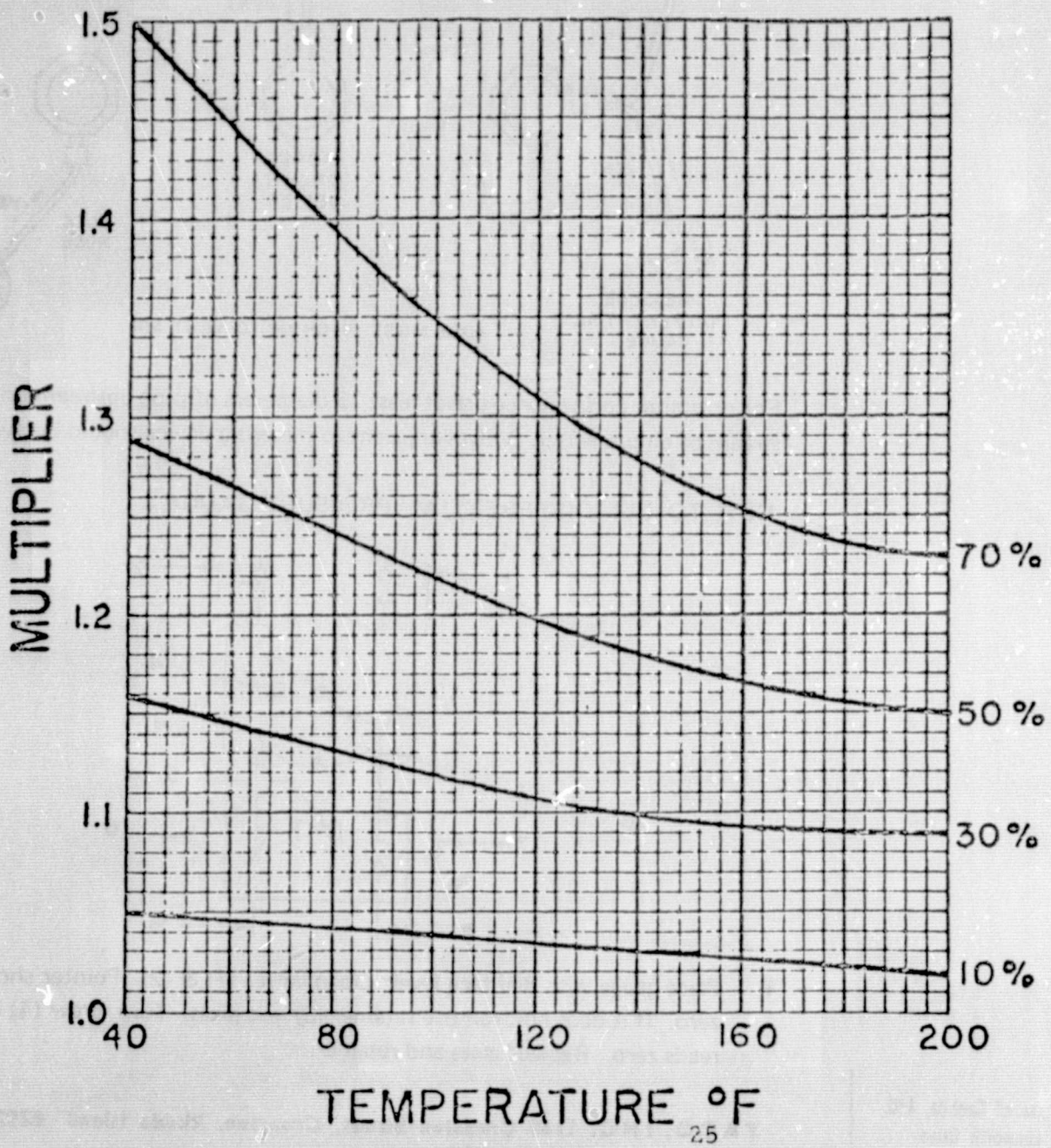
Differential Pressure Gauge Dimensions

MODEL	OVERALL CASE DIMENSIONS			Minimum	Reading	% Of Accuracy
No.	Length	Width	Height	Differential	Range	
788	*12¼"*	*6⅜"*	*6"*	*2'*	*2' – 100'*	*1.0%*
789	*14"*	*9½"*	*7"*	*.5'*	*.5 – 100'*	*.5%*

SHIPPING WEIGHT FOR DIFFERENTIAL READOUT METERS: 789 – 16 Lb.
788 – 5 Lb.

CHART 19

PRESSURE DROP MULTIPLIER FOR GLYCOL SOLUTIONS



INSTRUCTION SHEET

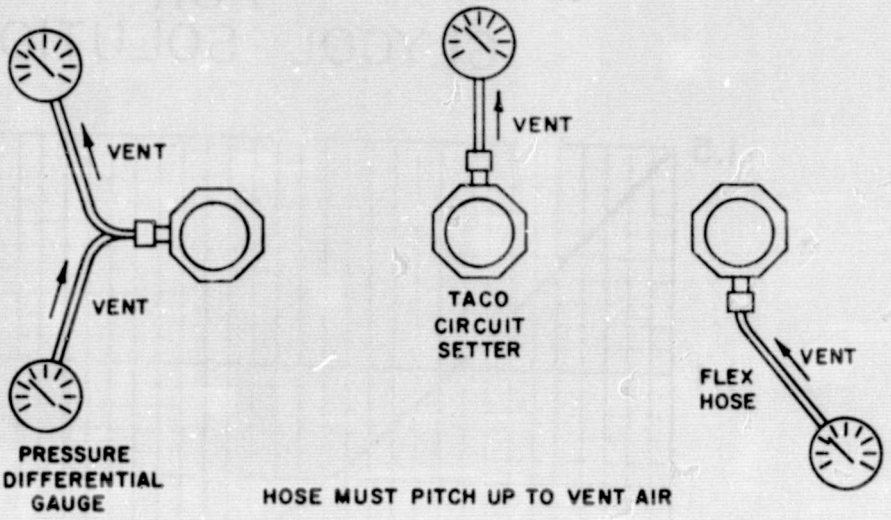
INSTRUCTION SHEET NUMBER

IS 400-4-4

TACO CIRCUIT SETTER

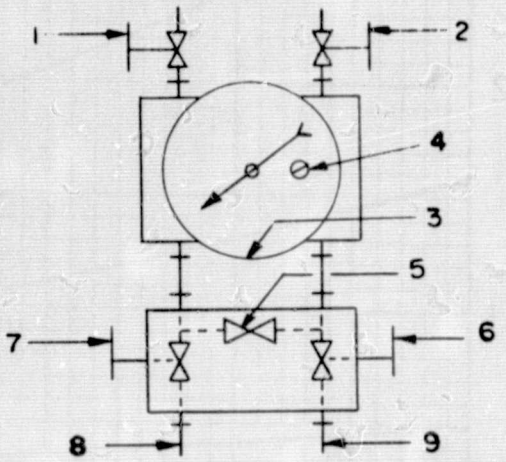
EFFECTIVE: May 15, 1972
Supersedes: NEW

Install circuit setter in position.
Keep in mind that when taking reading, hoses from readout gauge to circuit setter must slope up to allow for venting. (see diagram below.)



For optimum performance use at least 15 diameters of pipe upstream and 4 downstream of circuit setter. Valves adjacent to metering device should be avoided.

HOW TO USE DIFFERENTIAL PRESSURE GAUGE

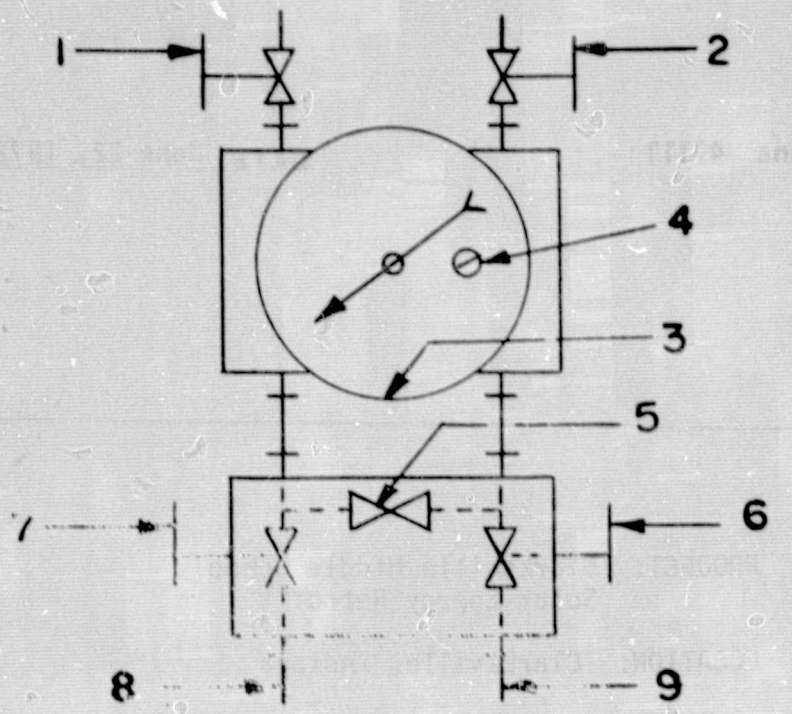


1. Place gauge with dial face level. Open valves (1) & (2). Pointer should read zero. If it does not, remove retainer (3) and glass. Turn screw (4) until pointer reads zero. Replace glass and retainer.

Taco Heaters of Canada, Ltd.
3090 Lenworth Drive
Cooksville, Ontario

TACO, INC. 1160 Cranston Street, Cranston, Rhode Island 02920

TACO CIRCUIT SETTER



2. Close valves (1) & (2). Open valve (5). Close valves (6) & (7)
3. Connect high pressure fitting (9) to upstream orifice tap and connect low pressure fitting (8) to downstream orifice tap of circuit setter using rubber hoses provided.
4. Open valves at orifice.
5. Open valves (6) & (7), and crack valves (1) & (2) until all air has been expelled from the gauge and hoses.
6. Close valves (1), (2), (6) and (7), keeping valve (5) open, pointer should then indicate zero. If it does not, air is trapped in the system. Repeat step 5 opening valves (6) & (7) alternately until all air is removed.
7. Open valves (6) & (7), close valve (5) and read pressure differential.
8. When through with test, open valve (5), close valves at orifice and remove hoses.
9. Open valves (1) & (2), and drain gauge and hoses.

Once pressure differential readings are taken, refer to calculator to obtain flow corresponding to observed differential.

If flow is not in accordance with design flow rate, reset valve and repeat procedure explained above. This may have to be repeated several times throughout the system except when valves have been preset in accordance with engineer's specifications.

RADEMAKER CORPORATION
2400 Watterson Trail
Bluegrass Industrial Park
Louisville, Kentucky 40299
(502) 267-9636

SUBMITTAL

Witten Brothers
P.O. Box 206
Charlestown, Indiana 47111

DATE June 22, 1978

PROJECT: Clarksville Middle School
Solar Energy Retrofit

LOCATION: Clarksville, Indiana

ARCHITECT & ENGINEER : Walker, Applegate, Oakes & Ritz

CONTRACTOR: Witten Brothers

EQUIPMENT: Temperature Controls

APPROVED

DATE: JUN 26 1978

WITTEN BROS.

MECHANICAL

JIM WITTEN

BY:

R. W. Rademaker

BY R. W. Rademaker/ms

CONTROLS

GENERAL INSTRUCTIONS

Reversible and Proportional Electric Actuators

MP-2000
MF & MP-310–389
MF & MP-410–489
MF & MP-4101–4899

DEVICE INFORMATION

Identification

Actuators of this family may be easily identified by referring to the part number shown on the actuator nameplate on top of the gear case. The date of manufacture is stamped on the case (four digits, the first two representing the week of the year, and the last two representing the year).

These actuators provide the requirements of both damper control and valve control applications where it is desirable to move the load in either direction, or to stop it at any point in the stroke.

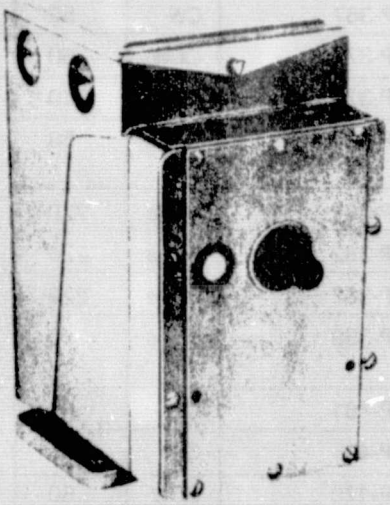
Pre-Installation

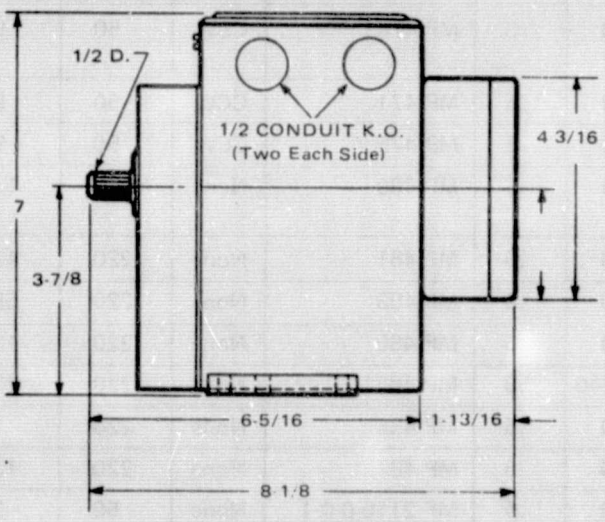
MF and MP actuators are shipped without mounting hardware or linkage. In damper applications, AM Series crank arms, connectors, link rods and mounting brackets will be required. In valve applications, a valve body and AV type linkage will be required.

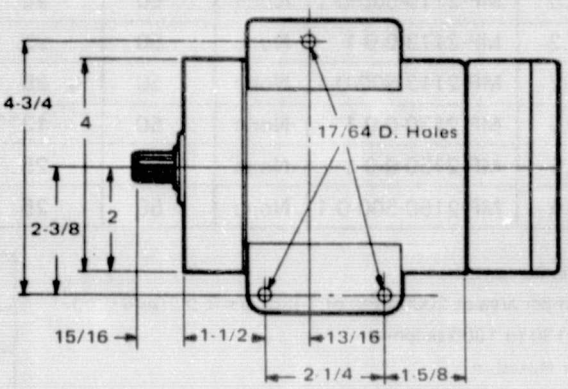
Before installing the actuator, look for bent or broken parts or oil leaks. Actuators may be connected to power supply to check operation prior to installation. See **CHECKOUT.**

Potentiometer: All standard MP actuators include a 100 ohm potentiometer except in the case of sequencing actuators where a 50 ohm resistance is furnished as standard. The active winding of the potentiometer is normally spread over 180 or 90 angular degrees, depending upon the limits of shaft rotation. The wiper arm is connected to the main output shaft through a slip clutch arrangement. If the shaft travels beyond the spread of the winding, the wiper arm will cease to operate once it has hit its stop and is not damaged. It will instantly start moving in the opposite direction as soon as the shaft reverses direction.

MP and MF actuators are available with special switching and wiring that enables the sequencing of two actuators. After the first actuator completes its travel, the second is energized and operates in turn. The reverse sequence occurs when operating in the opposite direction. Both low and line voltage actuators can be obtained with this type of construction.







INSTALLATION

Requirements

For longest life, ambient temperatures should not exceed the limits of −40°F and +140°F. Refer to Performance table for further information. Input is 28 watts and the VA rating is 50.

REVERSIBLE & PROPORTIONAL ELECTRIC ACTUATORS

PERFORMANCE

Input †		Part Number	Spring Return	Torque (Lb.-In.)	Timing (Sec/180°)	Nominal †† Damper Area (Sq. Ft.)		Auxiliary Switch	24 Volt Transformer	Travel Limit Switch
(VAC) 60 Hz	(Amps)					Parallel	Opposed			
24	2.5	MP-361	CW	50	90	28	36	SPDT	No	Yes
24	2.5	MP-367	CW	50	90	28	36	Sequencing	No	Yes
24	2.5	MP-371	CCW	50	90	28	36	SPDT	No	Yes
24	2.5	MP-377	CCW	50	90	28	36	Sequencing	No	Yes
24	2.5	MP-379	CCW	50	90	28	36	Selective Limits	No	Yes
24	2.2	MP-381	None	220	130	122	157	SPDT	No	Yes
24	2.2	MP-382	None	220	*	122	157	SPDT	No	Yes
24	2.2	MP-387	None	220	130	122	157	Sequencing	No	Yes
24	2.2	MP-389	None	220	130	122	157	Selective Limits	No	Yes
120	.5	MP-461	CW	50	90	28	36	SPDT	No	Yes
120	.5	MP-465	CW	50	90	28	36	SPDT	Yes	Yes
120	.5	MP-470	CCW	50	90	28	36	Selective Limits	Yes	Yes
240	.3	MP-4701	CCW	50	90	28	36	Selective Limits	Yes	Yes
120	.5	MP-471	CCW	50	90	28	36	SPDT	No	Yes
120	.5	MP-475	CCW	50	90	28	36	SPDT	Yes	Yes
120	.5	MP-480	None	220	130	122	157	Selective Limits	Yes	Yes
120	.5	MP-481	None	220	130	122	157	SPDT	No	Yes
120	.5	MP-483	None	220	65**	122	157	SPDT	No	Yes
120	.5	MP-485	None	220	130	122	157	SPDT	Yes	Yes
208/240	.3	MP-4851	None	220	130	122	157	SPDT	Yes	Yes
120	.5	MP-486	None	220	*	122	157	SPDT	Yes	Yes
120	.5	MP-487 □	None	220	130	122	157	Sequencing	No	Yes
120	.5	MP-2110-0-0-1	None	50	25	28	36	None	No	No
120	.5	MP-2110-500-0-1	None	50	25	28	36	SPDT	No	No
24	2.2	MP-2113-0-0-1	None	50	25	28	36	None	No	No
24	2.2	MP-2113-500-0-1	None	50	25	28	36	SPDT	No	No
120	.5	MP-2130-0-0-1	None	50	13**	28	36	None	No	No
120	.5	MP-2150-0-0-1	None	50	25	28	36	None	Yes	No
120	.5	MP-2150-500-0-1	None	50	25	28	36	SPDT	Yes	No

† All actuators, 28 watts

†† Nominal damper area at 2000 FPM or 1 inch static pressure drop.

* Adjustable, 130 to 1300 seconds.

** 90° Angular Rotation

□ Can be used in 50 or 60 Hz applications

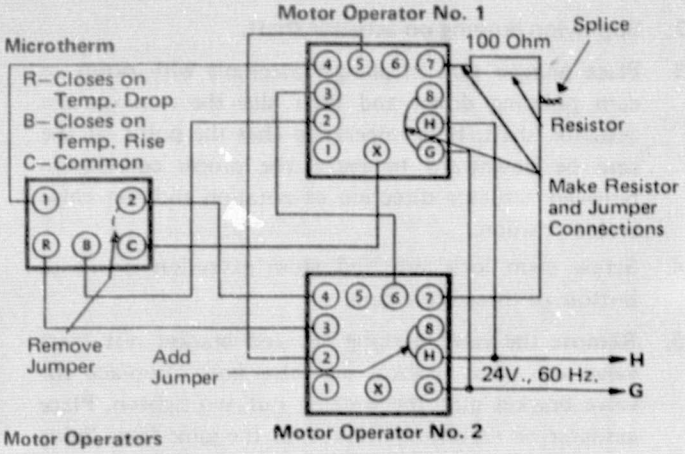
Auxiliary Switch Electrical Rating	120 Volts	240 Volts
Running Current	5.8 amps	2.9 amps
Locked Rotor	34.8 amps	17.4 amps

Procedure

Wiring: Make all electrical connections in accordance with the job wiring diagram and in compliance with national and local electrical codes. For power wiring on low voltage actuators (H and G terminals), use No. 14 wire on runs under 140 feet and No. 12 wire on longer runs. When powering many actuators from a common transformer the G terminals must all connect to the same side to prevent transformer damage. Low voltage thermostat cable can be used for control wiring provided all circuits to actuator originate from a Class II source, including actuator power supply. On line voltage units (L1 and L2 terminals) use No. 14 wire up to runs of 2100 feet. Line voltage units include a barrier which separates the line voltage terminals from the low voltage. All connections to the line voltage side of the barrier (L1 and L2, 1, 5, and 6 terminals) must be made with Class I wiring; connections to the remaining terminals can be Class II thermostat cable if desired. Particular attention should be given to the job wiring diagram in regards to the location of face jumpers and resistor connections to the actuators, particularly on the MP type actuators. On low voltage MP actuators, a face jumper is normally required between terminals H and 8, along with connecting the fixed 100 ohm resistor to terminal No. 7 (one end being factory anchored to ground). When the auxiliary switch is used, a face jumper is usually required between terminal H or G and terminal No. 1.

EXTERNAL WIRING

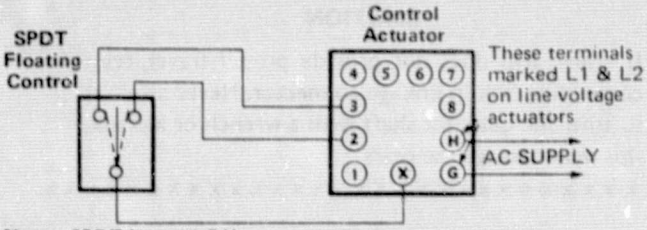
Sequencing



2– Rotates CW or Closes Valve
3– Rotates CCW or Opens Valve

Figure 2

Reversible Floating



Note: SPDT Neutral Off Switch may be used on manual positioning applications.

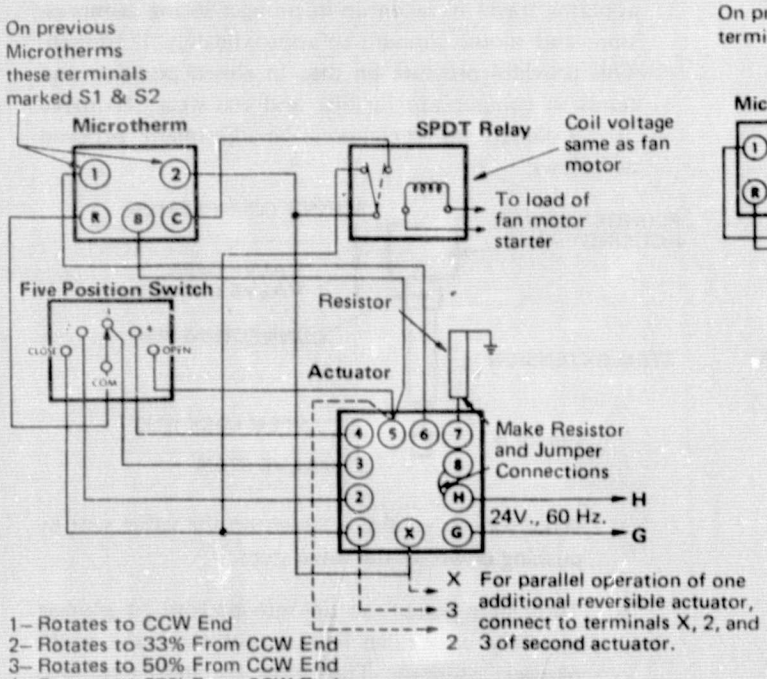
Note: Switch control circuit is 0.5 amp. at approximately 24V. AC on either low or line voltage actuators.

2– Rotates CW or Closes Valve
3– Rotates CCW or Opens Valve

Terminals 1, 5 and 6 are used for built-in auxiliary switch.

Figure 4

Reversible Selective Limits

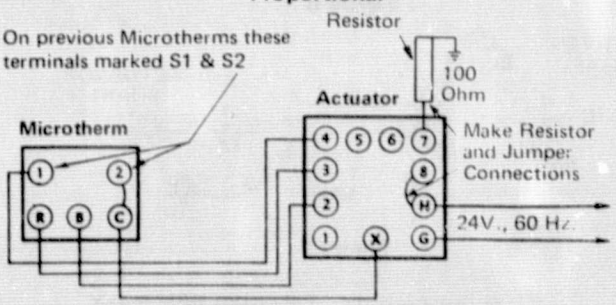


For parallel operation of one additional reversible actuator, connect to terminals X, 2, and 3 of second actuator.

1– Rotates to CCW End
2– Rotates to 33% From CCW End
3– Rotates to 50% From CCW End
4– Rotates to 67% From CCW End
5– Rotates to CW End

Figure 3

Proportional



Terminals 1, 5 & 6 are used for optional auxiliary switch when furnished.

2– Rotates CW or Closes Valve
3– Rotates CCW or Opens Valve

Figure 5

Damper Mounting: Do not mount MP or MF-2000 series adjustable speed actuators upside down. Do not mount justable speed units with output shaft up. Other MP and F actuators may be mounted in any position, although ne upright position is preferred.

Linkage: Figure 7 illustrates linkage for a 180° actuator operating an arm through a 90° arc. To fasten linkage proceed as follows:

1. Fasten linkage connector at end of driven crank shaft arm.
2. Fasten linkage connector at punch mark on actuator crank arm (about .707 of the radius).
3. Move damper to normal position and clamp connecting link to connectors.
4. Check adjustment for proper operation by running actuator and driven shaft between limits of travel.

CAUTION

If crank arm does not provide proper travel, reset connecting link in linkage connector. Never attempt to turn the actuator shaft with a wrench or a crank, this may damage the gears.

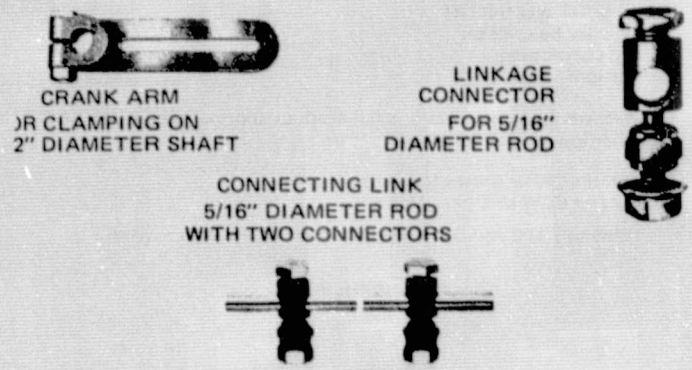


Figure 6

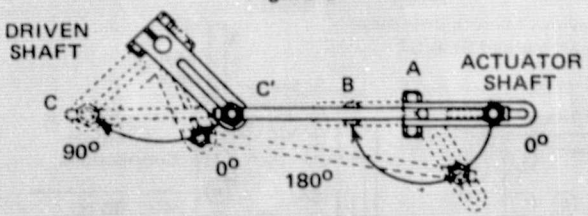


Figure 7

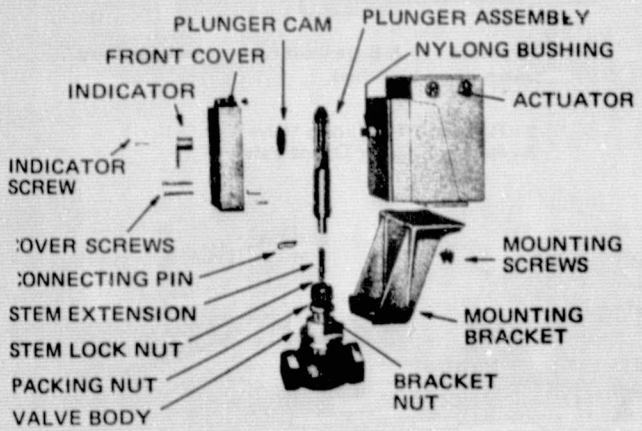


Figure 8

Valve Installation: Install all globe type valves with pressure under seat except where a flow direction arrow on the valve body indicates otherwise. Proportioning three-way valves should always be installed for mixing service (two inlets and one outlet).

Preferred mounting is with valve stem upright, but can be mounted in other positions. Valve assemblies using an adjustable speed actuator should never be mounted upside down or with front (indicator side) of actuator facing up.

Linkage: Valves are normally factory assembled and tested prior to shipment, but when necessary, to assemble the actuator to a valve, proceed as follows:

1. Apply power to terminal H and G (or L1 & L2). Install a jumper from terminal 2 to X. Run actuator shaft to clockwise end of rotation (short tooth of output shaft at 9 o'clock). Remove jumper when position is obtained.
2. Slip nylon bushing on actuator shaft.
3. Place plunger cam in plunger assembly with point of cam pointing down and then slip the cam on the actuator shaft. It is imperative that the point of the cam be downward to assure the proper correlation between actuator direction of rotation and the valve closed position.
4. Screw stem lock nut and stem extension down to bottom of threads on stem.
5. Remove the valve packing nut and bracket nut from valve and place bracket on valve body. Replace the valve bracket nut, the packing nut and tighten. Place actuator on mounting bracket, at the same time lining up plunger assembly over the stem extension. Fasten actuator to the mounting bracket with the three 1/4-inch-20 screws provided.
6. Plunger spring compression adjustment: Length of stem should be adjusted so valve disc seats before actuator reaches end of closing stroke. Balance of actuator travel is taken up in plunger spring compression, and should amount to approximately 1/16-inch. This provides pressure on disc in closed position and tends to compensate for disc and seat wear. To make proper plunger spring compression adjustment, proceed as follows:

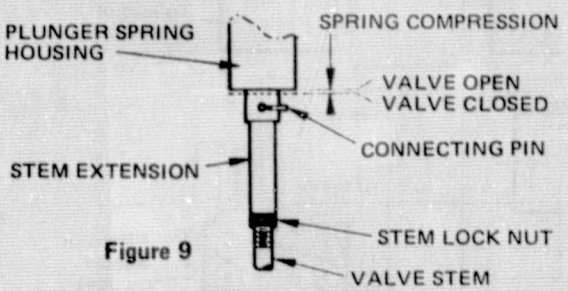


Figure 9

a. Make sure valve disc is down on the valve seat by pushing down on the valve stem.

b. Turn stem extension up into bottom of plunger assembly until holes line up with the holes in the plunger assembly. Then turn the stem extension two complete turns further in the same direction.

c. Run actuator partly open by placing a jumper between terminals 3 and X and raise until the connecting pin can be inserted through the plunger and stem extension holes together. Tighten stem lock nut against stem extension.

NOTE: On three-way valves, spring compression should be provided on both upper and lower seats.

7. Place front cover over plunger assembly and fasten to the actuator with the self-tapping screws provided. Install position indicator to end of actuator shaft by lining up the peg in the indicator with the notch in the plunger cam. Then tighten in place with the screw provided.

CHECKOUT

After the system has been installed, the following checks for proper system operation may be used.

1. Turn the thermostat to call for cool. Actuator should rotate clockwise and turn off heating media.
2. Turn the thermostat to call for heat. Actuator should rotate counterclockwise and turn on heating media.

To check actuator operation, turn off power and connect terminals as follows:

1. Figures 2, 4 & 5 – Connect power to the input terminals (H and G or L1 and L2) and then jumper either terminal 2 or 3 to terminal X. Grounding 2 runs the actuator clockwise and grounding 3 runs it counterclockwise.
2. Figure 3 – Connect power to the input terminals (H and G or L1 and L2) and then jumper either terminal 1 or 5 to terminal X. Grounding 1 runs the actuator counterclockwise and grounding 5 runs the actuator clockwise.

RUN/ADJUST

Theory of Operation

Actuator variations are shown in the following internal wiring diagrams.

Low voltage proportional actuators are furnished with a resistor and jumpers to be connected into the rebalance circuit. When actuator is to run counterclockwise on a call for heat, the resistor and jumpers should be connected as shown in Figure 10. When actuator is to run clockwise on a call for heat, the resistor and jumper connections to terminals 7 and 8 should be interchanged. When used on control applications where a separate rebalancing potentiometer 12 VAC power supply is furnished, do not make jumper or resistor connections to terminals 7 or 8. Line voltage proportional actuators usually have a built-in transformer to supply low voltage to the rebalance circuit (Figure 11). On these types, the fixed resistor is omitted. MF factors are used for reversible or floating control and have no built-in transformer or potentiometer.

MP and MF actuators for selective limit control. The resistor and potentiometers shown in dotted lines are included in low voltage proportional actuators (Type MP), but are omitted on floating control units (Type MF). The resistor and jumpers should be wired-in as shown in Figure 10 when operator is to run counterclockwise on a call for heat. When actuator is to run clockwise on a call for heat, these resistors and jumper connections to terminals 7 and 8 should be interchanged. When used on control applications where a separate rebalancing potentiometer power supply is furnished, do not make jumper or resistor connections to terminals 7 or 8. Line voltage proportional units omit the resistor and use a transformer as in Figure 11. The power terminals on these actuators are marked L1–L2 instead of H–G.

Internal Wiring

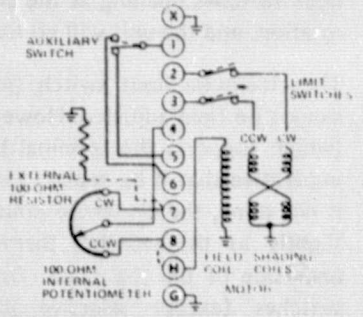


Figure 10 Proportional and Floating

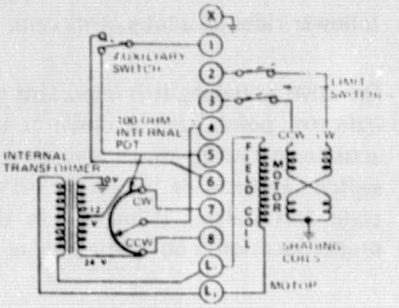


Figure 11 Proportional and Floating

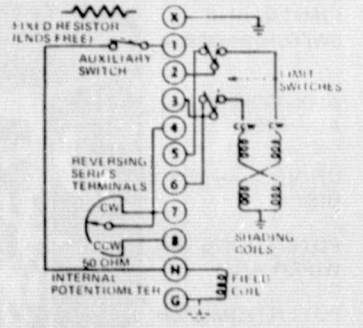


Figure 12 Sequencing

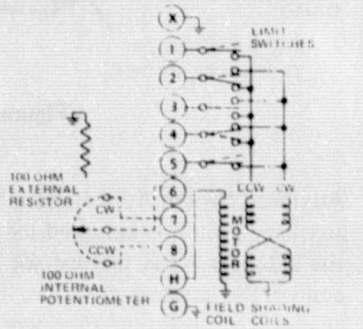


Figure 13 Reversible Selective Limits

Adjustment

Limit Switch Adjustment: The counterclockwise limit switch of all actuators is adjustable. Factory setting is usually for 180° of actuator rotation. Settings other than these are available upon request. This setting can be changed in the field by inserting a screwdriver through the opening in the top plate directly ahead of the terminal block and engaging the screwdriver with the notched cam nearest the front of the actuator. Turning the cam clockwise (as seen from the front of the actuator) increases the length of actuator rotation up to a maximum 320°. (This adjustment is not possible from the top with selective limit units. The back cover must be removed and the adjustment made with a screwdriver.) Each click of the cam represents about 3° change in actuator rotation. Attempting to adjust for more than 320° rotation will result in both limit switches opening at the clockwise end of the actuator rotation, and the unit will no longer operate.

The clockwise limit switch (middle switch) is fixed and cannot be field adjusted. However, if the actuator top plate (which supports the terminal block) is ever removed, it is imperative that it be replaced in its original position. If this is not done, the clockwise limit switch setting may change slightly as the switches themselves are anchored to the underside of the top plate. On MP & MF units with limit switches (except selective limit units) clockwise and counterclockwise rotation is stopped when the switch cam follower rides up a lobe of its cam.

On valve actuators, it is important that the plunger cam and indicator point straight down at the clockwise end of the actuator rotation. Minor adjustments in the clockwise limit switch can be made to accomplish this by loosening the top plate and shifting it slightly in the screw slots until the proper location is obtained (Figure 14).

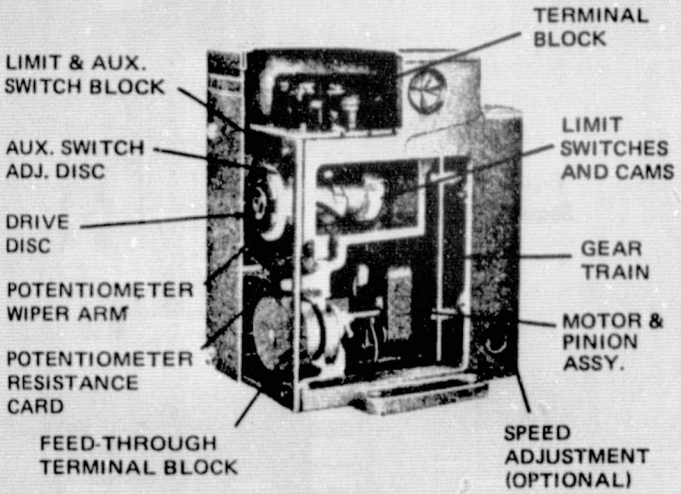


Figure 14

Auxiliary Switch Adjustment: The adjustable built-in SPDT auxiliary switch is actuated by the cam nearest the back of the actuator. It is factory set to operate at the clockwise end of the actuator rotation. This operating point may be changed by inserting a screwdriver through the opening in the top plate directly behind the terminal block, and engaging the screwdriver with a gear-like plastic disc (Figure 15). Turning the disc clockwise (as seen from the front of the actuator) causes the switch to operate nearer the counterclockwise end of actuator rotation. Each click of the cam represents about 3° change in operating point. The auxiliary switch is made from terminal No. 1 to terminal No. 5 until the cam follower rides up the lobe of its cam making terminal No. 1 to terminal No. 6. See Auxiliary Switch Electrical Rating.

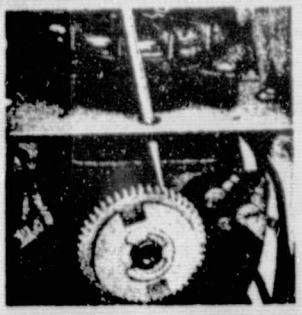


Figure 15

NOTE: When actuator travel has been increased beyond 180°, the auxiliary switch may, depending on its actuating point, operate twice in a given actuator stroke. For this reason, the auxiliary switch should be used with extreme caution where more than 180° of actuator rotation is used.

The auxiliary switch is not available on selective limit or sequencing actuator units.

Speed Adjustment: The timing of adjustable speed actuators is varied by a slotted adjustment screw on the lower left side of the front housing. Turning the screw clockwise decreases the speed. Total timing can be increased to about ten times the normal. For example, an actuator whose timing is normally 260 seconds per revolution can be reduced in speed to approximately 2600 seconds per revolution. Take care not to turn the adjustment screw too far clockwise as this will stall, although not damage, the actuator. If stalling occurs, turn screw counterclockwise until the motor resumes operation. The total adjustment is normally 3-1/2 turns. This feature is on units with the 3rd digit 2, 4, 6 or 8.

MAINTENANCE

A minimum of maintenance is required since the motor and gear train are submerged in oil for continuous lubrication and cooling. If necessary to refill the actuator with oil, always use Barber-Colman immersion oil, which is available in one quart cans (Refill Capacity – 1 to 1-1/4 pints). For best performance, oil level (with the actuator upright) should be up to the edge of the oil fill hole located in the front case of the actuator. The only exception to this is an adjustable speed actuator that is mounted with the adjusting screw pointing up. In this case, lay the actuator on its back when refilling with oil.

REPAIR

System

Internal wiring diagrams are shown in the **RUN/ADJUST** section of this GI. If the procedures in the **CHECKOUT** Section of this GI indicate that the actuator and thermostat are functioning properly, but correct temperature control is not obtained, refer to the list below for possible causes:

1. Microtherm in wrong location for proper sensing.
2. Improper air distribution.
3. Microtherm not properly calibrated.
4. Improper throttling range.
5. Microtherm has dirty contacts.
6. Microtherm cover has slots blocked.
7. Heating media unavailable.
8. Heating media will not shut off.
9. Actuator will not run (check power, gear train, linkage, travel limit switches).

Device

Normally actuators are returned to the factory for reconditioning if the need arises. However, field repairs can be performed. Refer to the repair parts list for parts and kits which are available.

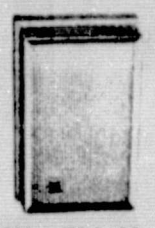
When ordering replacement parts, always include the part number of the actuator along with a description of the part required. For example, one resistance card assembly for an MP-481 actuator.

When refilling an actuator, refer to the appropriate portion of the Section on **MAINTENANCE**.

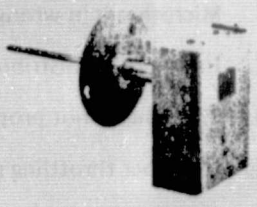
Temperature Sensing

GENERAL INFORMATION

Sensing is accomplished by the use of a temperature sensitive Balco resistance wire packaged in the form of room, duct, averaging and outdoor type configurations. The design of the entire system is around a 1000 ohm sensing element at 70°F.



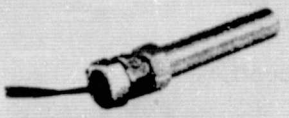
ROOM – TS-8100 SERIES



DUCT/IMMERSION – TS-8201

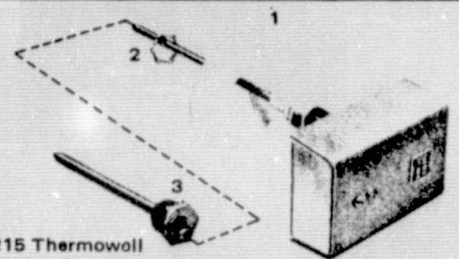
WIRING

Make all electrical connections to the element in accordance with the installation wiring diagram for the job. Comply with national and local electrical codes. Do not use the element box as a junction box for other control circuits. It is generally advisable to use flexible conduit for connecting box to rigid conduit. Restrict element leads to shortest length practical. Barber-Colman twisted cable or factory approved cabie should be used.



OUTDOOR – TS-8501

AVERAGE – TS-8400 SERIES

Part No.	Use	Location	Mounting	Terminal Code Wiring
TS-8101	Room Sensor w/o Setpoint	Wall		⑦ ⑧ Output Terminals
TS-8111	Room Sensor w/Setpoint	Wall		
TS-8201	Duct Immersion	Duct or Well	 	Pigtails: Black, Black (C) Controlling Black, Black (L)* Controlling *Found Only on the TS-8331
TS-8331	Lagged Sensor	Duct		
TS-8405	5' Average	Duct		
TS-8422	22' Average	Duct		
TS-8241	Diffuser	Ceiling	Mount on Face of Ceiling Diffuser. See Instructions for B-C Models PB, PS or SFS, SFB. Pg. 2	Pigtails: Black, Black
TS-8261	Light Fixture	Light Fixture	Mount in Return Grill of Light Fixture	Pigtails: Black, Black
TS-8501	Outdoor Air	Outside of Building	Use Conduit Connectors	Pigtails: Black, Black Controlling
TS-8531	Solar	Outside of Building		Orange, Orange Element (Solar)
TS-8533	Econostat	Outside of Building		Red, Red Heater (Econostat)

Solid State Humidity Sensing

ensing is accomplished by the use of a nonorganic resistance type material which will be housed either in a room or duct type mounting base. Selection of the proper AH-100 series element will provide the capability of control over a 15% range. Elements are available through the span of 5% to 95% R.H.

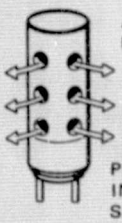
The average resistance of each element at midrange, is approximately 22,000 ohms; except the violet element, which is 50,000 ohms. A resistor of appropriate value may be substituted in the bridge circuit to verify the element resistance.

CAUTION

Do not measure resistance of element with an ohmmeter, as DC voltage across the element will cause polarization and a new element will be required. Basic element is not repairable. Order a replacement from the factory or local branch office.

CARE OF ELEMENT

The elements are wrapped with a moisture pervious cellophane, which actually is an air filter. On installations using duct elements, where air velocities are reasonably high **do not remove cellophane.** Always install element with wrapping so that perforations in cellophane are on downstream side of air currents. Punch more holes (only in downstream side of cellophane) to increase element sensitivity.



Sensing Element Color	Relative Humidity Range
Violet	85% to 95%
Blue	70% to 85%
Green	50% to 70%
Yellow	40% to 55%
Orange	30% to 45%
Brown	10% to 30%

WIRING

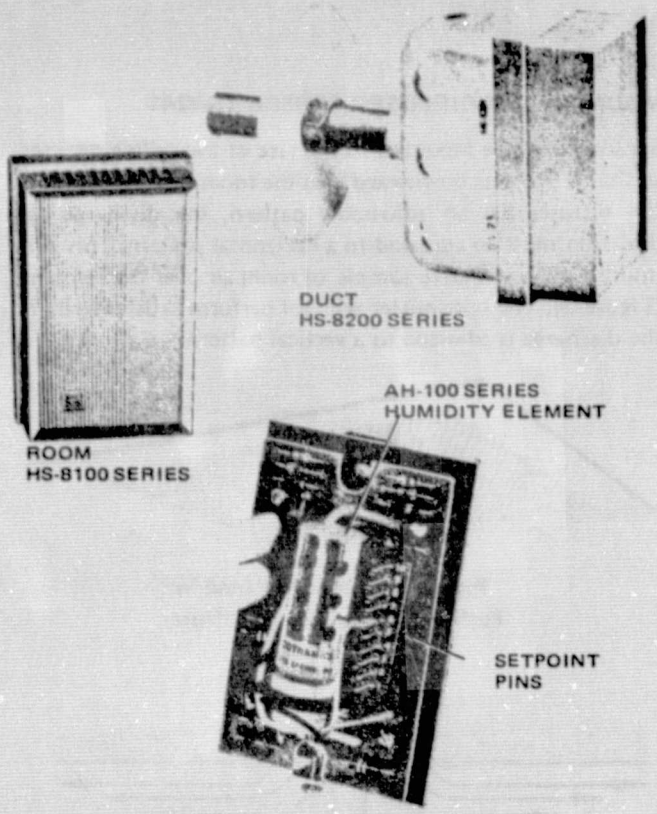
Make all electrical connections to the device in accordance with the installation wiring diagram for the job. Comply with national and local electrical codes. Restrict element leads to shortest length practical, using three conductor twisted cable, 18 gauge minimum.

CAUTION

Power wiring must never be installed in the same conduit.

LOCATION

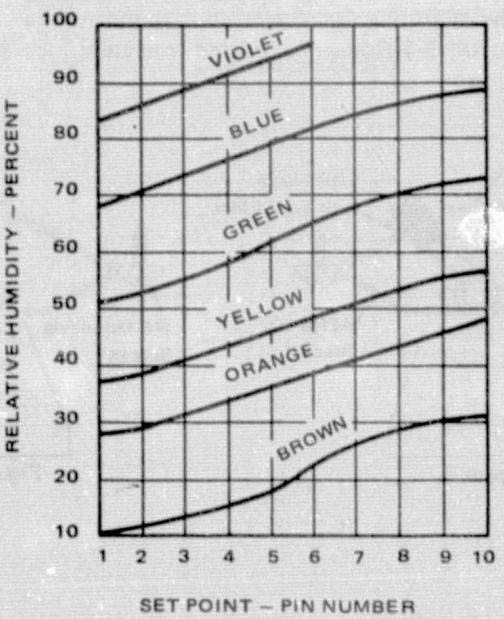
Locate the sensing element where it will be exposed to unrestricted natural air circulation and to the average conditions of the controlled space. Do not locate it near extreme sources of heat, cold, or moisture.



CALIBRATION

1. Place DC-VOM on output of CP-8102 controller, OP1 (+) and COM (–).
2. Read humidity at the sensor.
3. Place jumper on proper pin, see figure and chart.
4. Adjust the controller (CAL A) to 7.5 VDC output.
5. Refer to CP-8102 literature if further details are required.

GENERAL INFORMATION



MOUNTING OF DIFFUSER SENSOR TS-8241

Sensor should be mounted to the face of the ceiling diffuser so that it projects downward into the room. See Figure 1. If the diffuser has an adjustable pattern, the discharge air direction must be adjusted to a horizontal pattern. This will insure a representative sample of room air over the element (Figure 2). The transmitter will not perform satisfactorily if the discharge is adjusted to a vertical pattern.

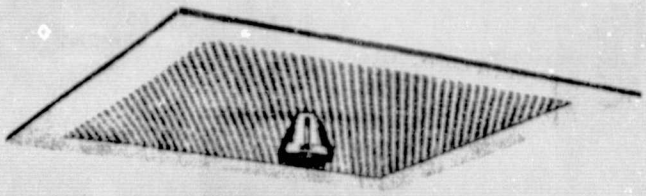


Figure 1. Sensor Mounted in Perforated Face Ceiling Diffuser Model PB or PS

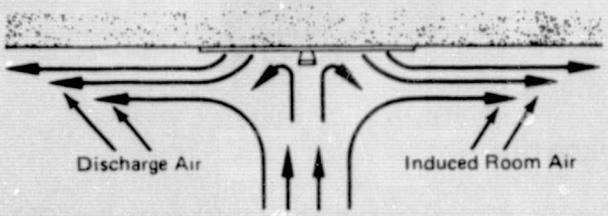


Figure 2. Room Air Induced Over Sensor by Discharged Air

A 7/16-inch hole is required in the diffuser face for mounting.

The SFS and SFB louver faced diffusers are available in nine air patterns, both in the square and rectangular design. For proper installation, use Chart 1 which shows sensor location and the mounting figure referred to in the installation procedure. APNS-107 must be ordered separately.

SENSOR MOUNTING PROCEDURE ON SFS AND SFB USING APNS 107 KIT

1. Drill a 5/16" hole for sensor leads.
   A. Fig. 3. Locate hole center on an angled surface about 5/16" from an edge of the 1/2" square so as to avoid drill contact with the welded center plate mounting brackets.
   B. Fig. 4. Locate hole center on one louver about 5/16" from junction of two center back to back louvers.
   C. Fig. 5. Locate hole center on an end louver about 1/2" from the junction of the louver and the mounting flange.
2. Bring field leads through the 5/16" hole. If required, remove the louver assembly from the mounting flange.
3. Center the APNS 107 bracket over the 5/16" hole (use as a template) and drill 1/8" holes for the mounting screws.
   A. Fig. 3. Drill two holes near edges of square center plate.
   B. Fig. 4. Drill two holes, one each on bottom edge of back to back louvers.
   C. Fig. 5. Drill one hole on end louver.
4. Assemble the sensor to APNS 107 bracket as shown in Figs. 3, 4, and 5.
   Fig. 5. Cut off one side of APNS 107 as shown.
5. Make field connections to sensor leads and push leads up through the 5/16" hole.
   Wrap friction or electrical tape around the leads and fill the 5/16" hole, preventing direct primary air passage over the sensor.
6. Attach APNS 107 as shown in Figs. 3, 4, and 5 using #6 screws.
   Fig. 5. Cover the crack between the end louver and mounting flange at least 12" on each side of the sensor. A 24" length of 3/4" tape stuck to mounting flange can be used.
7. The sensor installation is complete.

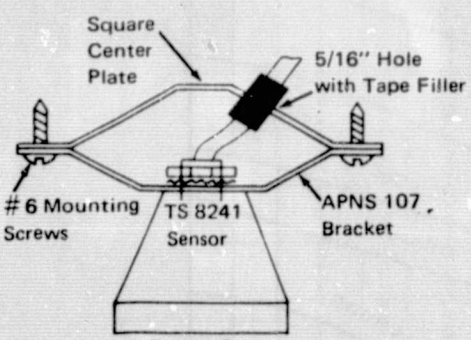


Figure 3.

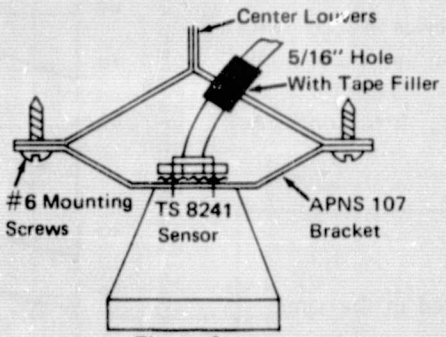


Figure 4.

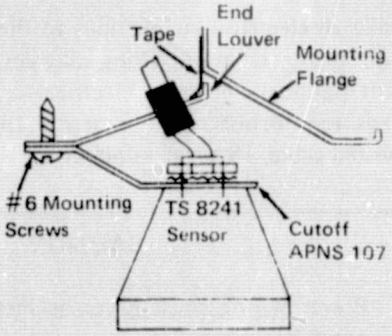


Figure 5.

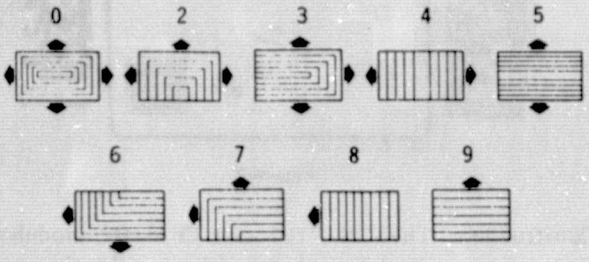
SENSOR LOCATION AND FIGURE SHOWING MOUNTING DETAILS

Air Pattern	SENSOR LOCATION							
	Center of Diffuser		Center of Side with No Air Throw		Corner Opposite Air Throw		End Opposite Air Throw	
	Sq.	Rect.	Sq.	Rect.	Sq.	Rect.	Sq.	Rect.
0	Fig.3	Fig.4						
2			Fig. 4					
3	Fig. 4							
4								
5								
6					Fig.3	Fig.5		
7								
8							Fig. 5	
9								

TS 8241 must not be located nearer than 18" from a wall or corner of a room when used on air patterns 2, 6, 7, 8, or 9. This allows space for induced air to pass over TS 8241.

AIR PATTERNS — (As Viewed From Diffuser Face)

Number is Air Pattern Designation When Ordering



Barber-Colman Company
ENVIRONMENTAL SYSTEMS DIVISION
1300 Rock Street, Rockford, Illinois, U.S.A., 61101

F-14970-3BK

LITHO IN U.S.A.

Multi-Purpose Bridge
2 - Input Controllers

General Information: The two input controller, Figure 1, is a self-contained package incorporating an integrated circuit amplifier and associated solid state discrete components with two bridges labeled A and B. The controller is designed to be track mounted in a local control panel, requiring only the connection of two wires from the sensing element and three wires from the controlled device to place the system into operation. The controller input terminals allow the connection of 1000 ohm sensors directly to bridges A and/or B, as well as connection of sensors through an auxiliary bridge (such as the multi-purpose bridge, Figure 2) to meet any application need. The design is such that a 1-15 volt DC drive type output with a low impedance is available to operate several controlled devices from one controller.

The multi-purpose bridge is designed to be used in applications of a complex nature meeting specific cycles of operation. It is used when the cycle calls for the application of lagged or solar type sensing elements or for cycles requiring three element control. This module is also designed to be mounted in a track located in a local control panel and obtains its power supply voltage from the two input controller. It produces a variable DC output which is supplied to the auxiliary bridge connections of the two-input controller, thus permitting specific cycles of operation to be met.

Installation Information: The multi-purpose bridge module, CN 8101, is designed to be track mounted and located in a local control panel. The unit is provided with a 7-1/2" piece of mounting track to permit quick and easy panel mounting, in a horizontal or vertical position. A 1000 ohm resistor is supplied with each unit.

The two-input controller module, CP 8102, is designed to be track mounted and located in a local control panel. The unit is provided with an 11" piece of mounting track to permit quick and easy panel mounting, in a horizontal or vertical position.

The location of these modules should be such that the unit is not subjected to severe vibration, shock, or ambient temperature limitations.

Make all connections in accordance with job wiring diagrams, Figure 5 and 6, complying with all national electric codes. Wiring terminations are made on screw terminals located on the end of the printed circuit board.

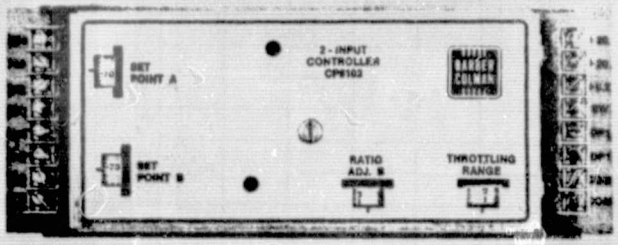


Figure 1

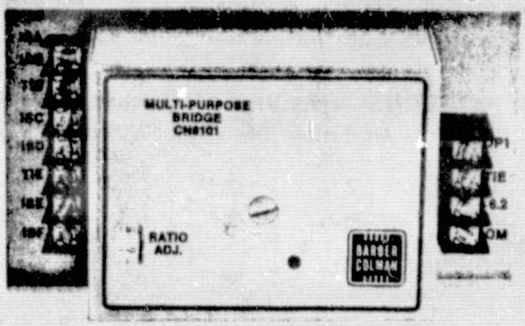


Figure 2

Construction: The CN 8101 and CP 8102 modules are designed primarily for track mounting in a local or central control panel. However, the CN 8101 may be located inside the AD 8910 enclosure for remote field mounted installations. The CP 8102 can be located inside the AD 8912 enclosure for remote field mounted installations.

Adjustments: Multi-purpose bridge, Figure 3 has adjustments for calibration of the sensing element to the bridge and a ratio adjust potentiometer. The ratio adjust potentiometer is available for setting ratios of .5 to 20:1 with respect to the main element of the two input controller. For example, if a 1:1 ratio is required in the system, the ratio adjustment potentiometer would be set at 1.

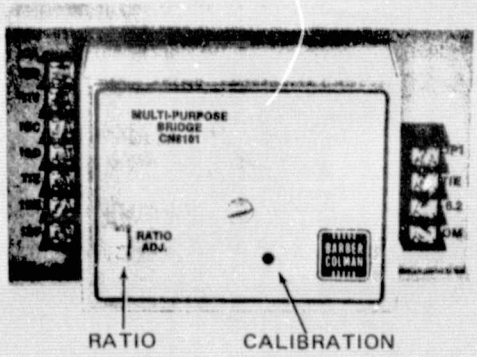


Figure 3

Two input controller, Figure 4 has adjustments available to permit calibration and selection of the proper ratio and throttling range to meet specific applications. With the sensing element connected to bridge A, the control point is .djustable from 20-120°F. by merely rotating the setpoint knob to the desired temperature. Should it be necessary to match the element to a given output voltage, a calibration adjustment potentiometer is also available. When a sensing element is connected to bridge B, calibration and setpoint adjustments are also available. The setpoint is adjustable from 20-120°F. with 1° adjustability. Also contained in bridge B is a ratio adjustment which can be set from .5 to 25:1. This means with the ratio adjustment set at 1, elements A and B have identical authority.

A throttling range potentiometer is available for setting the throttling range of the system from 2-10°F. (measured when the output voltage varies from 6-9 volts DC).

Calibration:

1. Apply +20 volts DC to terminals +20 (+) and common (-).
2. Connect VOM (10,000Ω per volt) to OP1 (+) and common (-).
3. Set throttling range potentiometer to 3 and ratio potentiometer to 1. Remove jumper AB2 and AB3.
4. Measure the temperature of element A and set setpoint potentiometer A to this temperature.
5. Calibrate bridge A to 7.5 volts output.
6. Replace jumper AB2 to AB3.
7. Measure temperature of element B and set setpoint adjustment B to match this temperature.
8. Calibrate bridge B to 7.5 volts output.
9. Remove the meter.
10. Place the throttling range and ratio potentiometers to desired setting for your application.

Note: A 1000Ω, 1% resistor may be substituted in place of the element. The setpoint potentiometer should be set at 70°F., and steps 3, 5, 6, 8, 9, and 10 should be followed.

Service:

1. Check wiring per job wiring diagram.
2. Measure with VOM
   A. Power supply 20 VDC terminals +20 and COM.
   B. Output 1-15 VDC terminals OP1 and COM.
   C. Input 1SA and 1SB 1000Ω sensing element.
3. Consult EN 111 for additional service information.

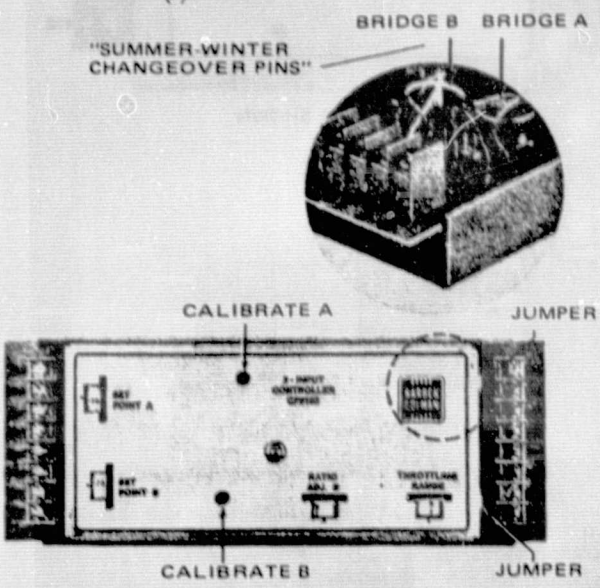


Figure 4

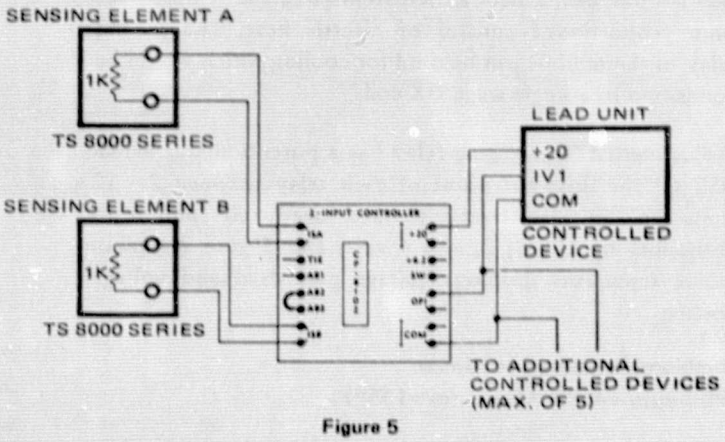


Figure 5

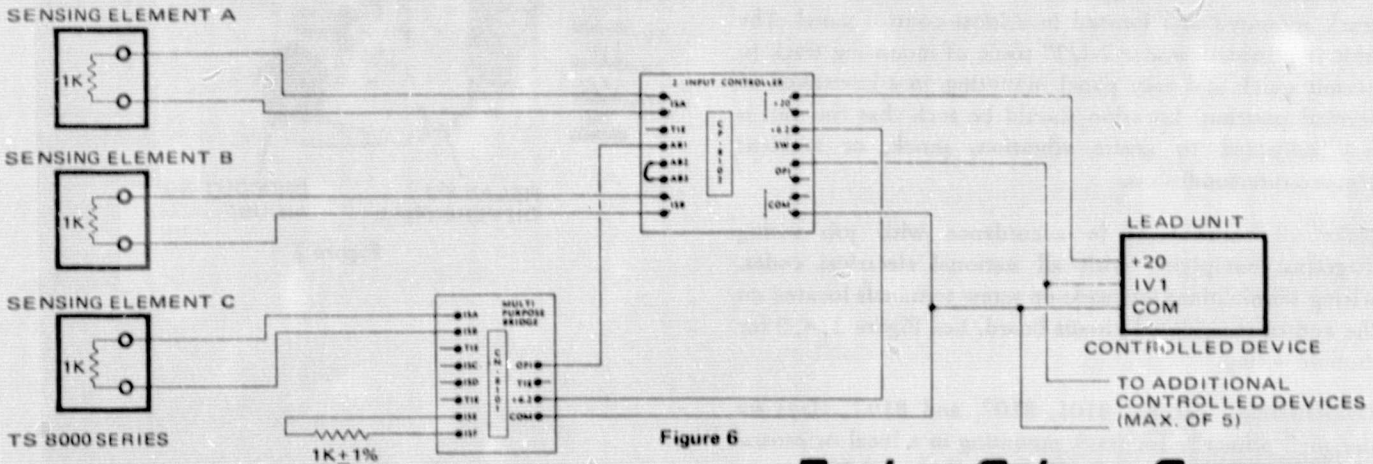


Figure 6

Barber-Colman Company
CONTROLS DIVISION
1300 Rock Street, Rockford, Illinois, U.S.A., 61101

F-14969-1 8K
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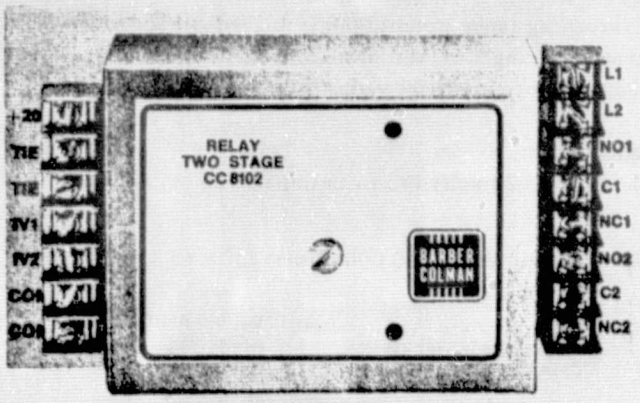
CONTROLS

GENERAL INSTRUCTIONS

Solid State Controlled Device
Single Stage Relay
Two Stage Relay
Time Proportioning Relay

TYPE:
CC 8101
CC 8102
CC 8103

General Information: Staging relays, Figure 1, are offered in various configurations which include single stage, dual stage, and dual stage with one stage containing heat anticipation. These staging relays require 120 volts AC for power source and contain a 20 volt DC regulated power supply which is used to supply power to other modules, such as controllers and adaptors. The staging relay receives a 1-15 volt DC input signal and by means of adjusting the drop-out voltage of each stage, the relays may be made to operate at any voltage in this 1-15 volt span. The differential of the relay is adjustable by selecting the proper pin on the printed circuit board.



TWO STAGE SHOWN

Figure 1

The time proportioning version of the staging relays can be used to control heating-cooling applications. The heating side is built with a heat anticipation circuit which provides time proportioned control of electric heat. The second relay in the module can be used for cooling which would be connected to a single stage DX coil.

Adjustments: The staging relay has a potentiometer which will set the drop-out point of each relay between 2 - 12 volts DC. It also contains fixed deadband (pull-in to drop-out) of 1/2, 1, 2, and 4 volts DC, Figure 2. Pull-in point represents drop-out voltage plus deadband voltage setting.

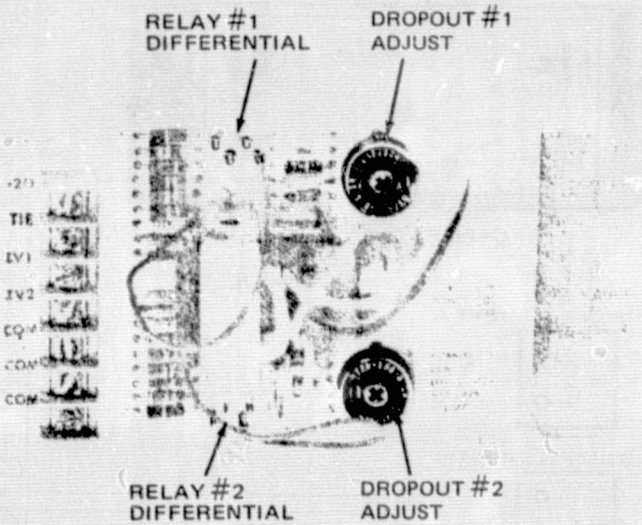


Figure 2

Ambient Temperature Limits:
Minimum +40°F; Maximum +135°F.

Installation Information: The module is designed to be track mounted and located in a local control panel. The unit is provided with a 7-1/2" piece of mounting track to permit quick and easy panel mounting, in a horizontal or vertical position. Location should be such that the unit is not subjected to severe vibration, shock, or ambient temperature conditions.

Make all connections in accordance with job wiring diagrams, complying with all national electrical codes. Wiring terminations are made on screw terminals located on the end of the printed circuit board. See Figure 3, 4, 5 for module wiring.

Construction: The CC 8101, 8102, and 8103 relays are designed primarily for track mounting in a local or central control panel. However, they can also be located inside the AD 8910 enclosure for remote field mounted installations.

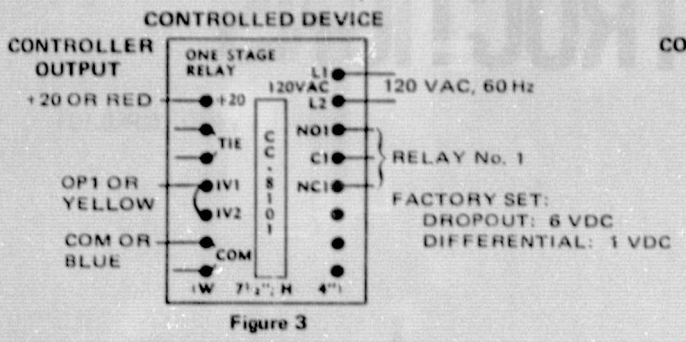


Figure 3

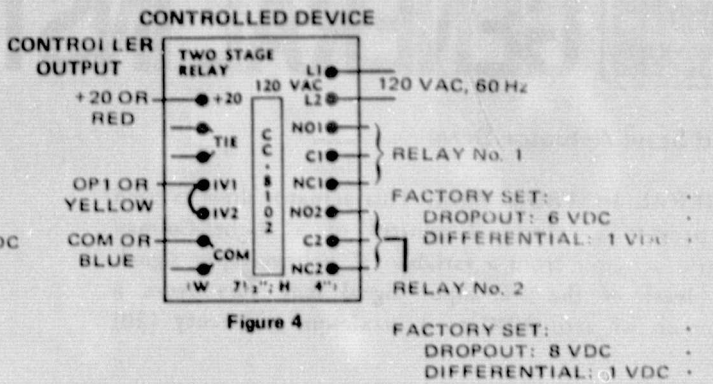


Figure 4

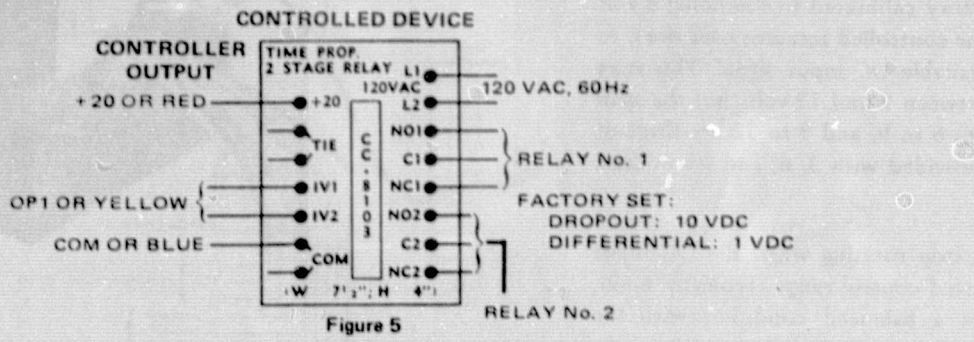


Figure 5

Calibration:

1. Apply power to relay module.
2. Connect VOM to input terminals IV1, IV2 and COM.
3. Set input voltage to desired drop-out voltage (IV1).
4. Adjust stage one for relay drop-out (R1).
5. Repeat steps 3 and 4 for stage two (R2).
6. Set differential to desired setting.

Service:

1. Check wiring per job wiring diagram.
2. Measure with VOM
   A. Power 120 VAC terminal L1 and L2.
   B. Power supply 20 VDC terminal +20 and COM.
   C. Input 1-15 VDC terminal IV1, IV2 and COM.
3. Consult EN 111 for additional service information.

ENVIRONMENTAL SYSTEMS

GENERAL INSTRUCTIONS

Solid State Actuator Drive

TYPE: CP-8301

GENERAL INSTRUCTIONS: This actuator drive is used to provide proportional control of a Barber-Colman electric actuator from a variable DC voltage input signal. The level of the DC input signal may vary from a minimum of zero VDC to a maximum of twenty (20) VDC.

The actuator drive is factory calibrated to a nominal 6 volt start point to position the controlled actuator over the 6 to 9 volt portion of the available DC input signal. This start point can be adjusted between 2 and 12 volts but the span is fixed at 3 volts. 3 to 6, 6 to 9, and 9 to 12 are three of the ranges that can be provided with 3, 6, and 9 volt start point adjustments.

The actuator shaft will stop rotating when the DC input signal is within the adjusted control range (typically 6–9), only if the input is in a balanced condition with the actuator feedback potentiometer, which indicates a satisfied condition between setpoint, actuator position, and controlled variable.

Up to six (6) actuator drives can be controlled from one variable (1 to 15 VDC) control signal supplied by a CP 8102 or TP 8101 controller.

Because all actuator drives require a 120 VAC power supply they are generally applied to only 120 VAC electric actuators. However, they can also be applied to other voltage actuators (24, 240, etc.). Typically the actuator drive will be panel mounted when applied to actuators of other than 120 VAC, because of their own 120 VAC requirement.

ACCESSORIES: The AD 8951 mounting assembly is an accessory provided to permit easy panel mounting and wiring of the CP 8301 actuator drive.

Connect actuator drive wires to the AD 8951 terminal strips marked (X, 2, 3, 4, 7, 8, L1, L2) and control signal red, yellow and blue wires to terminals R, Y, B.

An 11" piece of mounting track is included.

MOUNTING INSTRUCTIONS: Actuator mounted drive - the actuator drive may be mounted on either side of an actuator by inserting the two (2) 1/2-inch nipples (on actuator drive) into the 1/2-inch knockouts provided on the actuator, securing the drive into place with the two (2) locknuts provided for that purpose (Figure 5).

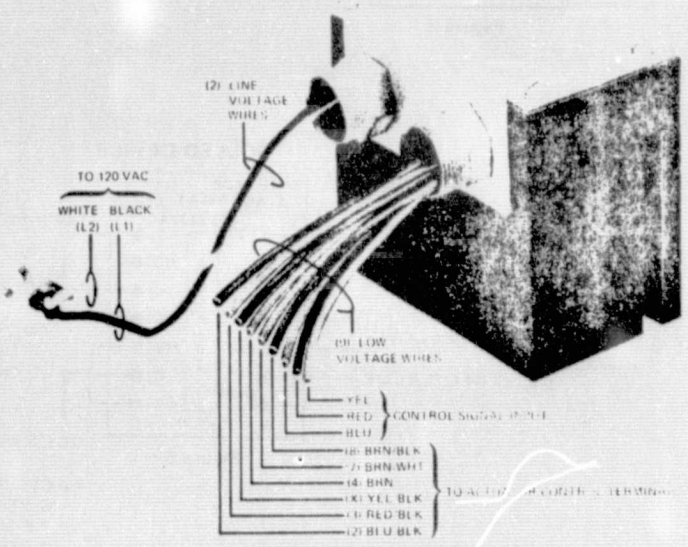


Figure 1. Actuator Drive

NOTE: The black and white (line voltage power) wires MUST ALWAYS be inserted directly into the actuator line voltage wiring compartment.

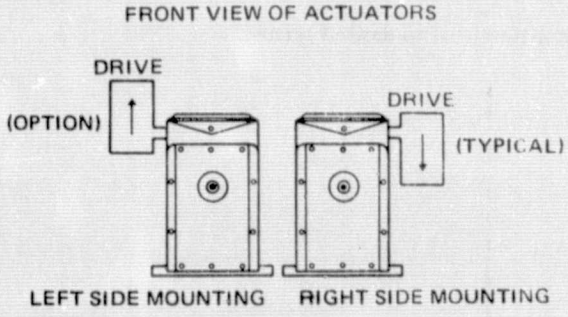


Figure 2. Left and Right Side Mounting

Panel mounted drive – the AD 8951 panel mounting assembly (see Fig. 3) provides the best method of panel mounting the CP 8301 actuator drive and is recommended. Simply remove the two CP 8301 cover screws, re-insert them through holes in mounting assembly and back into their original position thus fastening the mounting assembly securely to the actuator drive. Install mounting track to panel and snap the AD 8951 into track, connect wires to correct terminals to complete panel mounting procedures. Remove two (2) mounting nipples and insert two (2) rubber grommets (supplied with AD 8951 kit) into same holes to protect wires.

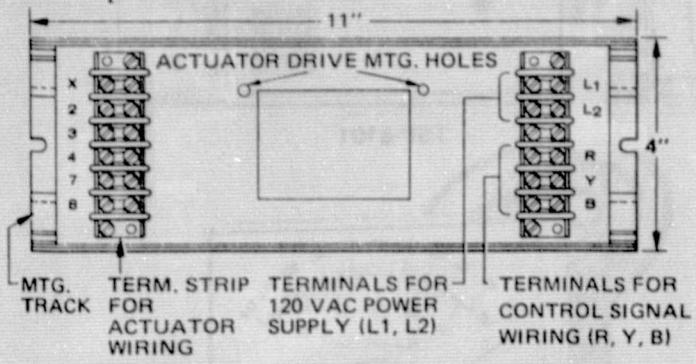


Figure 3. AD 8951 Mounting Assembly

WIRING INSTRUCTIONS:

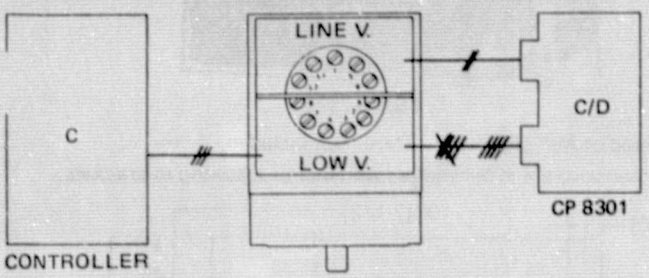


Figure 4. System Schematic

Actuator Mounted Drive: Connect the actuator drive wires with lugs directly to the appropriate actuator terminal numbers (see Fig. 1 and 5). Make all wiring runs between the actuator drive and the controlling device with a minimum size of #18 wire.

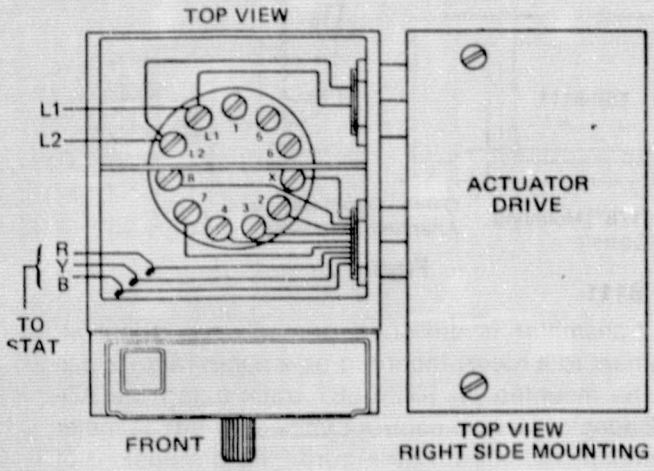


Figure 5. Wiring Arrangement

Panel Mounted Drive: Make all wiring runs between the AD 8951 mounting assembly terminal strip and the controlled actuator with a minimum size of #16 wire; make all wiring runs between the AD 8951 mounting assembly terminal strip and the controlling device with a minimum of #18 wire.

DIMENSIONS: (See Fig. 6)

D1 =	OVERALL DRIVE CASE (WITH FITTINGS) DEPTH	= 3¼"
D2 =	DRIVE CASE ONLY DEPTH	= 2½"
H1 =	DRIVE ONLY HEIGHT	= 4"
H2 =	OVERALL DRIVE & TRACK HEIGHT	= 5"
L =	TRACK & BRACKET OVERALL LENGTH	= 11"
W1 =	DRIVE WIDTH	= 4"
W2 =	OVERALL WIDTH (DRIVE, BRACKET & TRACK)	= 4"

DRIVE ONLY HEIGHT – H1 = 4"
OVERALL W/TRACK HEIGHT – H2 = 5"

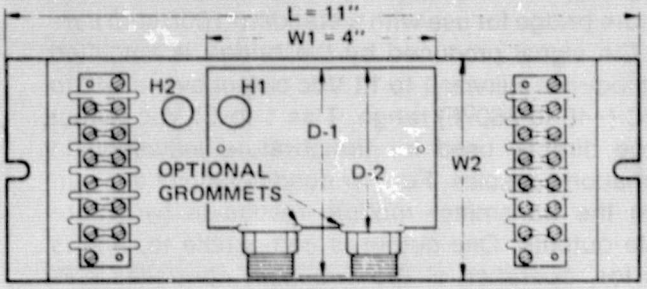


Figure 6. Panel Mounted Wiring Diagram w/Dimensions

Power Requirements: 120 VAC; 60 Hz; 5.5 watts and minimum size wire recommended – #16.

Shaft Rotation With Signal Voltage Increase	Actuator Terminal Numbers			
	2	3	7	8
	Actuator Drive Wire Colors			
CW* (Standard)	BLU/BLK	RED/BLK	BRN/WHT	BRN/BLK
CCW (Optional)	RED/BLK	BLU/BLK	BRN/BLK	BRN/WHT

*Standard Application Requires CW Rotation with Control Voltage Increases

ADJUSTMENTS:

Start Point Adjustment: Factory setting = 6 volts DC nominal; Adj. full CW = Max. start point; Adj. full CCW = Min. start point.

NOTE: 3 volt span is not adjustable. The span is the **number of volts change** required to run actuator full travel.

DEVICE LIMITATIONS:

Ambient temperature variations:
Minimum = –40°F
Maximum = 140°F

Solid State Temperature Transmitter Module Temperature Indication Transmitter TSP-8101, TSP-8111

DEVICE INFORMATION

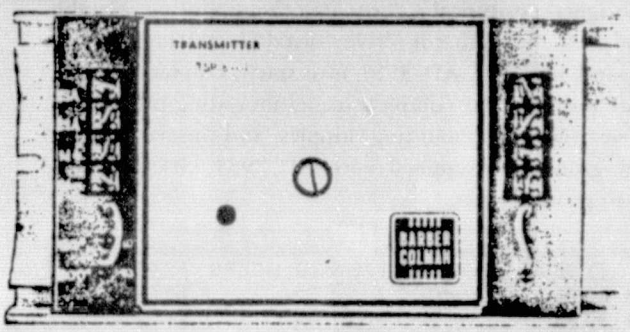
Identification

TSP-8101

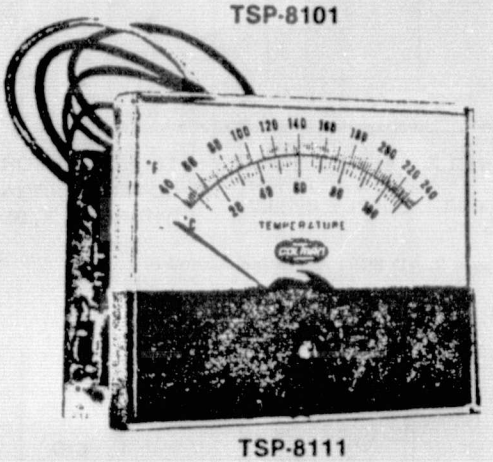
The solid state temperature transmitter is a self-contained package. It incorporates several integrated circuit amplifiers and associated solid state components. The transmitter is designed to be track mounted in a local or central control panel. It is used in systems where temperature indication and/or control is required. The circuitry features a stable temperature bridge for use with a standard 1000 ohm sensor. The signal produced by the bridge is amplified and produces a linear 1 to 11 Vdc output over a –40 to 127°C (–40 to 260°F) range. This 1 to 11 Vdc output can be directly used for temperature indication in automation consoles. Further conditioning of this output in the transmitter module results in two more usable outputs. One output is compatible to, and is used for, operation of the two-input controller (CP-8102). The other is for driving a 1 to 11 Vdc indicating meter (ASP-500 Series) over a selected temperature range and span.

TSP-8111

This transmitter is for temperature indication only. It incorporates an amplifier and bridge to condition non-adjustable TS-8000 1000 ohm sensors to produce a 1 to 11 Vdc output signal. The output signal is applied to ASP-500 Series temperature indication meters which cover ranges through –40 to 116°C (–40 to +240°F). TSP-8111 is factory calibrated for use with ASP-561 meter, –40 to 71°C (–40 to 160°F) range. TSP-8111 must be field calibrated to other ASP-500 meters. A power supply is required and can be either 20 Vdc or 24 Vac.



TSP-8101



TSP-8111

(Mounted on ASP-563 meter) Meter Not Included.

All Dimensions are in Millimeters with Inches following in brackets.

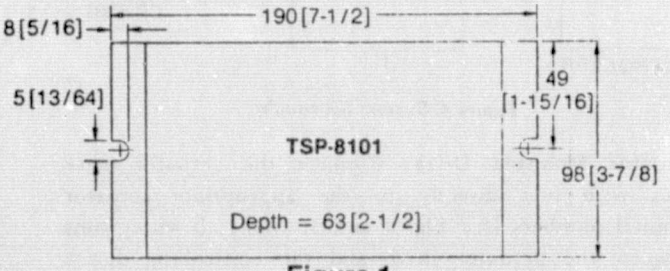


Figure 1

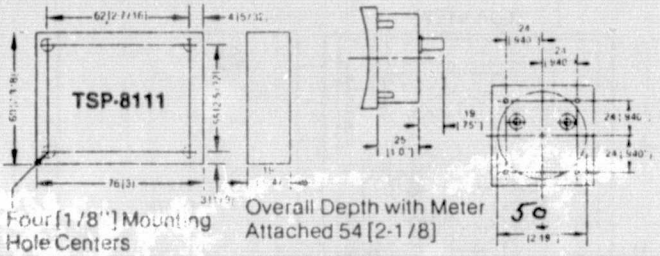


Figure 2

INSTALLATION

Requirements

TSP-8101

Space requirements are indicated by the dimensions shown in Figure 1. The TSP-8101 is designed primarily for track mounting in a local or central control panel. However, it can also be located inside the AD-8910 enclosure for remote field mounted installations. The module is constructed with screw type terminals for field and inter-module wiring connections. A selector type pin arrangement is used for obtaining the desired indication meter spans and also for direct or reverse outputs for operation of the two-input controller.

TSP-8111

The transmitter is designed primarily for direct attachment to a meter mounted on a panel face. It can also be mounted on SYZE-567 track using the AD-8952 adaptor plate in control cabinets when the meter is remotely mounted. See Figure 2 for dimensions of TSP-8111 and ASP-500 Series meters. TSP-8111 and an ASP-500 Series meter can also be mounted in an AT-221 enclosure (Figure 4).

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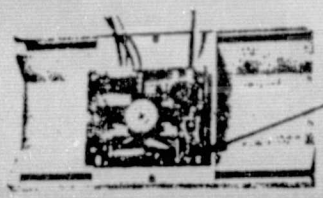


Figure 3

Mount the TSP-8111 to the AD-8952 adaptor plate mounting studs using four 4-40 X 5/16" round head screws as shown in Fig. 3. Install the SYZE-567 track in the cabinet using #8 or #10 sheet metal screws. Insert the AD-8952 into the track slots as shown.

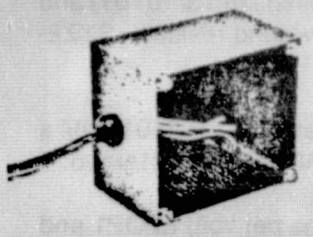
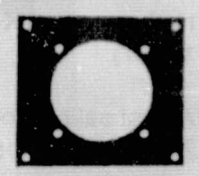


Figure 4



Wall Or Duct Mounting Enclosure **AT 221**

For direct mounting the TSP-8111 and ASP-500 Meter on a wall or a duct. The kit includes the housing, cover and mounting screws. Housing has an opening on the left side with a Heyco clamp to hold low voltage power and element leads. The enclosure dimensions are 96mm [3-3/4] wide by 86mm [3-3/8] high by 61mm [2-3/8] deep. Two mounting holes are on the back of the case.

PERFORMANCE

TSP-8101

Ambient Operating Temperature: 4 to 58°C (40 to 135°F).

Power Supply: 20 ± 1 Vdc, 13 mA.

Input: Standard 1000 ohm sensor.

Indication Output: A linear 1 to 11 Vdc output for either 27.5°C or 110°C (50°F or 200°F) span, featuring a meter zero calibration potentiometer. Output impedance is approximately 10 ohms.

Controller Output: Compatible for either direct or reverse operation of the standard two-input controller (CP-8102). The system uses the -6 to 49°C (20 to 120°F) internal setpoint adjustment of the two-input controller, or any of the AT-8100 Series remote setpoints.

Automation Console Output: A linear 1 to 11 Vdc output for a temperature range of -40 to 127°C (-40 to 260°F). The output impedance is approximately 10 ohms.

TSP-8111

Ambient Temperature: 4 to 58°C (40 to 135°F).

Power Supply: 20 Vdc ±1 at 12 mA, or 24 Vac ±10% at 20 mA.

Input: Non-adjustable 1000 ohm Balco sensor.

Output: A linear 1 to 11 Vdc output for either 27.5°C (50°F) or 110°C (200°F) spans. Up to five identical ASP-500 meters will indicate from one TSP-8111. Output impedance is approximately 10 ohms. The load resistance must not be less than 3000 ohms.

Connections: Two terminal clips (+ and -) connect directly to a meter. Two black sensor leads, blue and red power leads, blue (-) and yellow (+) leads connect to a remote meter. All leads are 152mm (6") long.

Accuracy: 2% of system span used

Sensor Lead Length: Can be used with runs up to 305m (1000 ft.) using 18 ga. twisted pair. Recalibration is required when leads exceed 91m (300 ft.).

TSP-8111 can be used with the following non adjustable 1000 ohm sensors.

Part Number	Description
TS-8101	Room
TS-8131	Room Button Type
TS-8201	Duct / Immersion
TS-8241	Diffuser
TS-8261	Light Fixture
TS-8405	5' Averaging
TS-8422	22' Averaging
TS-8501	Outdoor

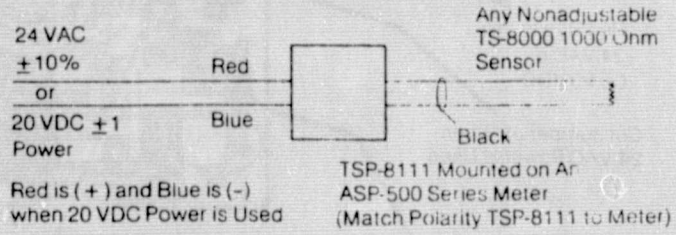
Procedure

TSP-8101

The module is provided with a 190mm (7-1/2") long by 101mm (4") wide piece of mounting track. This permits quick and easy panel installation in either a horizontal or vertical position. Make all connections in accordance with job wiring diagrams, and comply with all national and local electrical codes. Wiring terminations are made on screw terminals located on the end of the printed circuit board. See Figure 8 for module wiring.

TSP-8111

Make all connections in accordance with the job wiring diagram and comply with national and local electrical codes. Clip out jumper J1 when 24 Vac power is used. Refer to Figure 7 for polarity of meter mounting clips. Match polarity to meter. The yellow lead is (+) and blue is (-). Refer to Figure 5 for single point temperature indication and to Figure 6 for multipoint indication applications. One meter can be used with any number of points of indication when using push button switches.



NOTE: Up to five identical remote ASP-500 meters will indicate from one TSP 8111. Tape off the yellow lead when TSP-8111 is mounted on the meter.

Figure 5

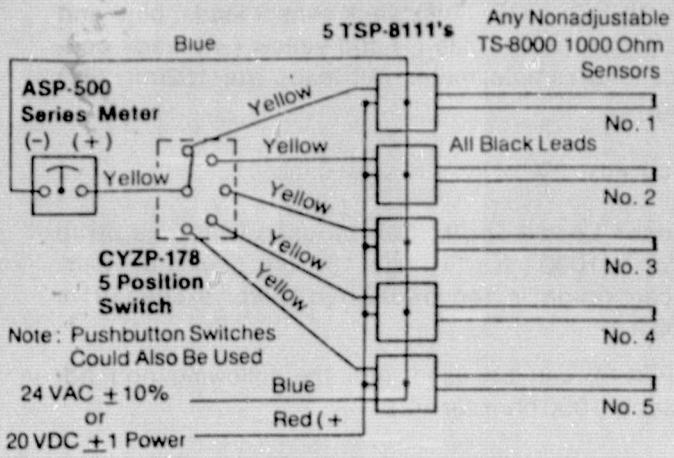


Figure 6

RUN/ADJUST

Adjustment

TSP-8101

The TSP-8101 has available a zero adjustment as well as 27.5°C or 110°C (50°F or 200°F) span selection pins for meter indication. Selection pins are available for either direct or reverse operation of the two-input controller.

TSP-8111

The TSP-8111 meter zero calibration potentiometer, span selection screw, 20 Vdc / 24 Vac jumper (J1) are provided and shown in Figure 7. The span of TSP-8111 must match the span of the meter 27.5°C or 110°C (50°F or 200°F).

Calibration

TSP-8101

1. Apply +20 Vdc to terminals +20 and COM of both the TSP-8101 and CP-8102.
2. Remove 1K sensor (ISA terminals of TSP-8101) and replace with 1K ±1% wire wound resistor (SYZE-12987).
3. Adjust calibration potentiometer in TSP-8101 until a 21°C (70°F) meter reading (ASP-500) is obtained.
4. Connect a VOM (10,000 ohms per volt) to OP1 and COM of CP-8102. Adjust setpoint A to 21°C (70°F) and the throttling range to 1.6°C (3°F) on the CP-8102. Adjust bridge A calibration potentiometer until a CP-8102 output of 7.5 Vdc is obtained.
5. The system is calibrated.

TSP-8111

1. Apply 20 Vdc or 24 Vac to the red and blue leads.
2. With the sensor in place, determine the temperature of the media with an accurate thermometer.
3. Turn the zero calibration potentiometer until the media temperature is shown on the ASP-500 Series meter. [Remove the span screw and washer for use with 27.5°C (50°F) span meters.]
4. The system is calibrated.

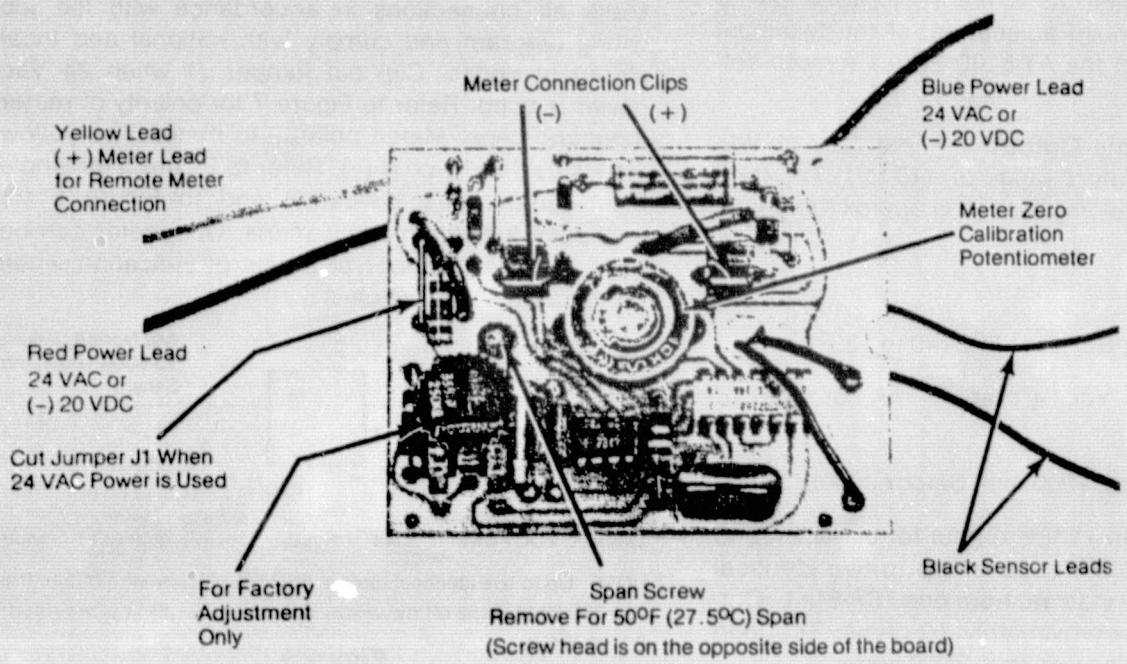


Figure 7

REPAIR

TSP-8101

Check wiring per job wiring diagram. (See Fig. 8)

2. Measure +20 Vdc supply using a VOM (10,000 ohms per volt) between +20 and COM of either the TSP-8101 or CP-8102.

3. Connect a VOM between OP1 and COM of CP-8102. A 1 to 15 Vdc output reading should be obtained by rotating setpoint A from fully ccw to cw position.

4. Consult EN 111 for additional information.

TSP-8111

1. Check wiring per job wiring diagram.

2. Measure supply voltage using a VOM. It must be to specifications. Note: Jumper J1 must be cut when 24 Vac power is used.

3. The span of TSP-8111 must match the meter. Use a VOM to obtain b and c readings below.

   a. The span screw and washer must be securely in place for 110°C (200°F) span units. Both screw and washer must be removed for 27.5°C (50°F) span units.

   b. Disconnect the TS-8000 sensor at TSP-8111. The voltage across the meter clips (or blue and yellow leads) must exceed 11 Vdc.

   c. Short the two black sensor leads of TSP-8111. The voltage across the meter clips (or blue and yellow leads) must be less than 1 Vdc.

4. In the event TSP-8111 is operating correctly, check the meter per EN 111, C 1.2 Page 13, Step 4 and TS-8000 sensor.

5. In the event the meter and sensor are operating correctly, but TSP-8111 is not, replace TSP-8111. Repair is not practical.

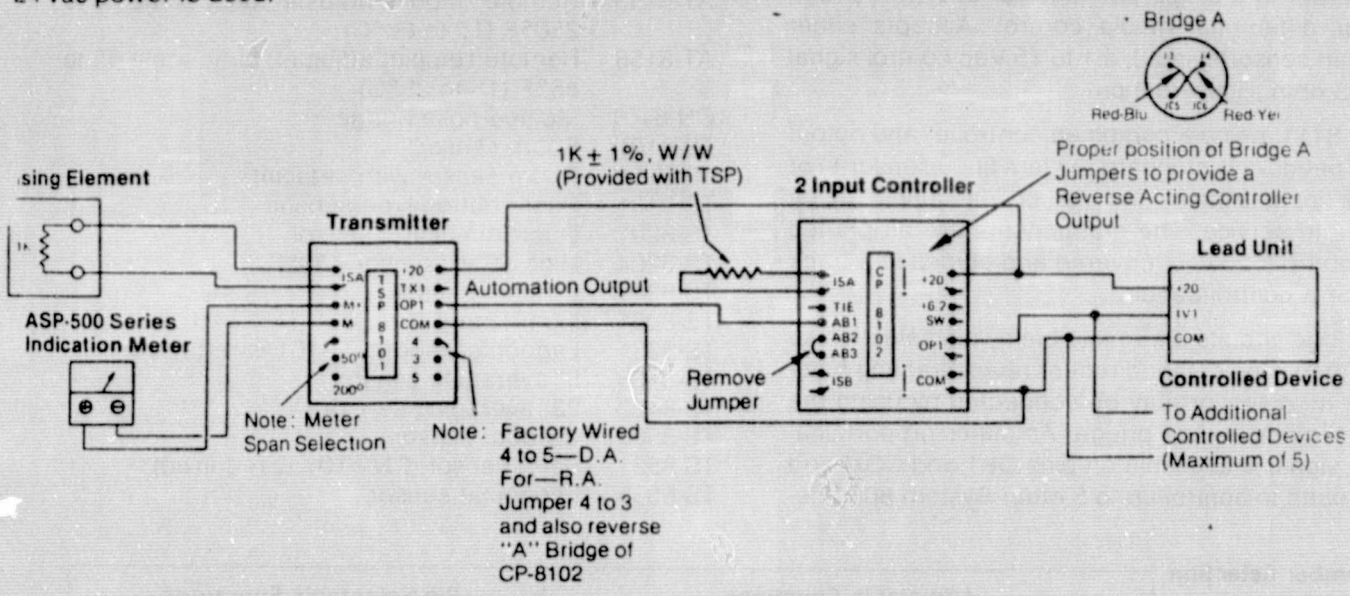


Figure 8

Barber-Colman Company
CONTROLS DIVISION
1300 Rock Street, Rockford, Illinois, U.S.A., 61101

F-15496-3 BK

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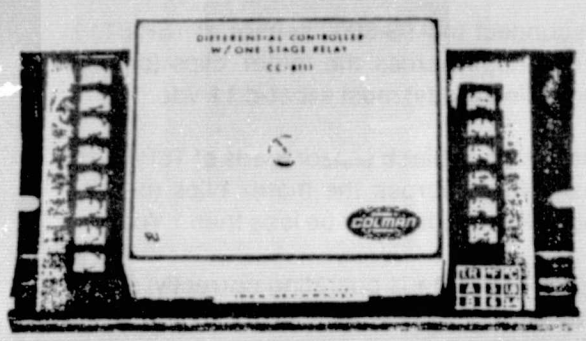
Product Information

Solid State Controller
Differential Controller
With One Stage Relay



CC-8111

Two input solid state controller with a single stage relay output in a single package for use with direct, reset or differential media control. Accepts either 1000 ohm sensor(s) input, a 1 to 15 Vdc control signal or a 135 ohm slidewire input.

The CC-8111, being a combined controller and output device, needs only standard System 8000 sensor(s) or optional input signals and AC power supply to be placed into service. The components are all printed circuit board mounted, covered and placed in a track ready for a control panel.

Input bridge circuits are reversible by pin selection so sensor(s) may be set for direct or reverse acting functions. A third sensor may be connected by using the CN-8101 multipurpose bridge. Amplifier proportional voltage signal is available on pins OP1 and COM and can be used to control up to 5 other System 8000 devices. Supplementary input voltages of 1 to 15 Vdc may be put into IV1 and COM for control of the output relay stage. Output power of 20 −1.5, +1 Vdc at 35 ma and 6.2 ±0.5 Vdc at 4 ma is available between +20 and 6.2 terminals and COM. WIRING CONNECTIONS: Coded screw terminals. AMBIENT LIMITS: 40 to 140°F. DIMENSIONS: 4 in. wide × 7.5 in. long × 2.5 in. deep.

Accessories

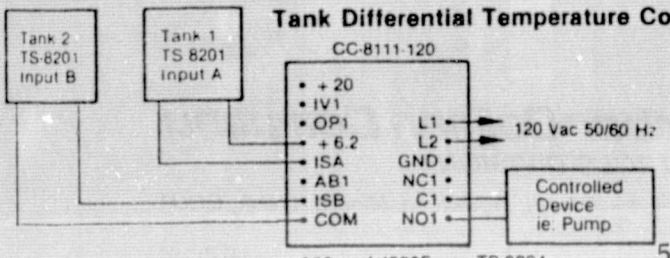
AD-8122	Signal adaptor for dual outputs (D.A.-D.A.)
AD-8123	Signal adaptor for dual outputs (D.A.-R.A.)
AD-8124	Signal adaptor for dual outputs (R.A.-D.A.)
AD-8910	10" enclosure
AT-8122	Remote setpoint adjuster, dual scale 20 to 120°F (−6 to 49°C)
AT-8155	Remote setpoint adjuster, dual scale 50 to 250°F (10 to 66°C)
AT-8158	Remote setpoint adjuster, dual scale 55 to 85°F (13 to 29°C)
CN-8101	Multipurpose bridge
TS-8101	Room sensor
TS-8111	Room sensor with setpoint
TS-8131	Room button type sensor
TS-8201	Duct/Immersion sensor
TS-8204	High temp. sensor 450°F
TS-8241	Diffuser sensor
TS-8261	Light fixture sensor
TS-8331	Lagged sensor (CN-8101 is required)
TS-8405	5' averaging sensor
TS-8422	22' averaging sensor
TS-8501	Outdoor sensor
TS-8531	Solar sensor (CN-8101 is required)
TS-8533	Econostat sensor

Part Number Selection and Function Chart

		Adjustable Functions				Pin Selectable Functions		
Part Number	**Power Req. 50/60 Hz**	**Setpoint "A"**	**Setpoint "B"**	**Diff. Range**	**Relay Dropout**	**Throttling Range**	**Authority Ratio**	**Relay Diff.**
CC-8111-024	24	41 to 95°F 5 to 35°C	41 to 95°F 5 to 35°C	1 to 54°F Std. By Added Res. 1-400°F	2 to 12 Vdc (IV1 to Com)	3.6 or 9°F 1.6, 3.4 or 5°C	.5 .75 1.0 15.0 Aux.	.5 1.0 2.0 4.0 Vdc (IV1 to Com)
CC-8111-120	120							
CC-8111-240	240							

TYPICAL APPLICATION

Tank Differential Temperature Control



NOTE: For temperatures between 250 and 450°F use TS-8204

Barber-Colman Company
CONTROLS DIVISION
1300 Rock Street, Rockford, Illinois U.S.A. 61101

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F-17191

JOHNSON CONTROLS

Johnson Controls, Inc
Penn Division

2221 Camden Court
Oak Brook, IL 60521

Series R34D Solid State Differential Temperature Controller—For Use With Nickel Wire Wound Sensors

Application

These differential temperature controllers are for use on applications where it is desirable to provide on-off control by the difference between two sensed temperatures. Controllers are supplied with calibrated adjustments.

Typical applications include:

— Solar heating systems.

— Fruit and vegetable storage spaces.

— Machine tool equipment.

These controllers provide a SPDT relay output that is switched according to the temperature differential measured by two Penn nickel wire resistance sensors. Sensor No. 1 is located in the lower temperature area and sensor No. 2 is located in the higher temperature being sensed.

Features

— Solid state components.

— Easy to install and wire.

— Field adjustable set points.

— Input from nickel wire wound sensing elements.

— Relay (SPDT) output.

General Description

The R34D resistance bridge output is amplified and compared to the two preset values. The results of that comparison operates an internal SPDT control relay. The relay is energized when the temperature at sensor No. 2 (higher temperature sensor) exceeds that of sensor No. 1 (lower temperature sensor) by more than the preset "△ T-ON" temperature differential. The relay remains energized until the temperature differential is less than the preset "△ T-OFF" differential. If the "△ T-OFF" set point is set higher than the "△ T-ON," the system is "ON" whenever the temperature differential is at or higher than the "△ T-OFF" set point. The "OFF" set point will control and the device will operate at the "OFF" setting with about 1F (.5C) △T differential.

Series R34D controller is available in a NEMA Type 1 enclosure with four mounting holes in back of case, or in an open construction which mounts on four standoffs within a control panel. External wiring is connected to identified screw terminals.

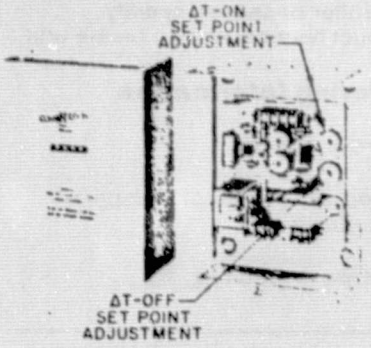


Fig. 1—Type R34DCA Differential Temperature Controller.

Specifications

Product	R34DCA	120 V., 50/60 Hz Input, NEMA Type 1 Enclosure
	R34DCB	120 V., 50/60 Hz Input, Open Construction
	R34DCG	24 V., 50/60 Hz Input, NEMA Type 1 Enclosure
	R34DCH	24 V., 50/60 Hz Input, Open Construction
Ambient Temperature At Controller		0 to 120 F (-18 to 49C)
Conduit Openings (NEMA Type 1 Models)		Combination Knockouts for ½" and ¾" Conduit. Three on Top, Three on Bottom.
Electrical Connections		Identified Screw Type Terminals.
Enclosure (NEMA Type 1 Models)		Cold Rolled Steel
Output Relay		SPDT (See Table for Electrical Rating)
Power Supply		24V.A.C. or 120V.A.C., 50/60 Hz, 5 Watts (9 VA)
Set Point Range (△T-ON and △T-OFF)		0 to 40 F (0 to 22 C)
Shipping Weight (Individual Pack)	With Enclosure	5.5 lbs. (2.5 kg)
	Open Construction	1.8 lbs. (.8 kg)

Repairs and Replacement

Field repairs must not be made If the controller needs servicing or repair, return it to the factory. Replacement controllers and sensors may be obtained from the nearest Penn-Baso Wholesaler. When ordering a replacement controller or sensor, specify Product Number shown on the unit.

Ordering Information

To order, specify:

1. Complete Product Number of controller.
2. Sensors required.

Electrical Rating For Relay Contacts

Volts A.C.	120	208	240	277
Full Load Amps.	5.8	5.4	4.9	—
Locked Rotor Amps.	34.8	32.4	29.4	—
Non-Inductive or Resistance Load Amps. (Not Lamp Loads)	10.0	8.0	8.0	7.0

Pilot Duty — 125 VA, 24/277 V. A.C.

Rating is 10 Amps at 28 V. D.C.

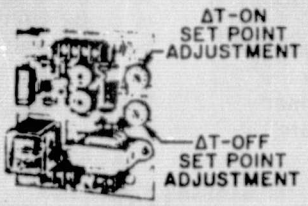


Fig. 2—Type R34DCB Differential Temperature Controller.

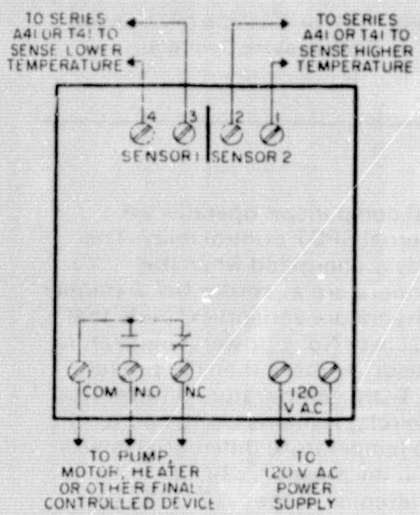


Fig. 3—Drawing of controller showing wiring connections.

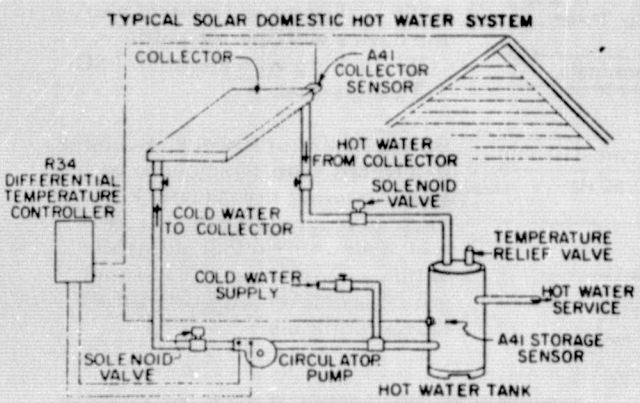
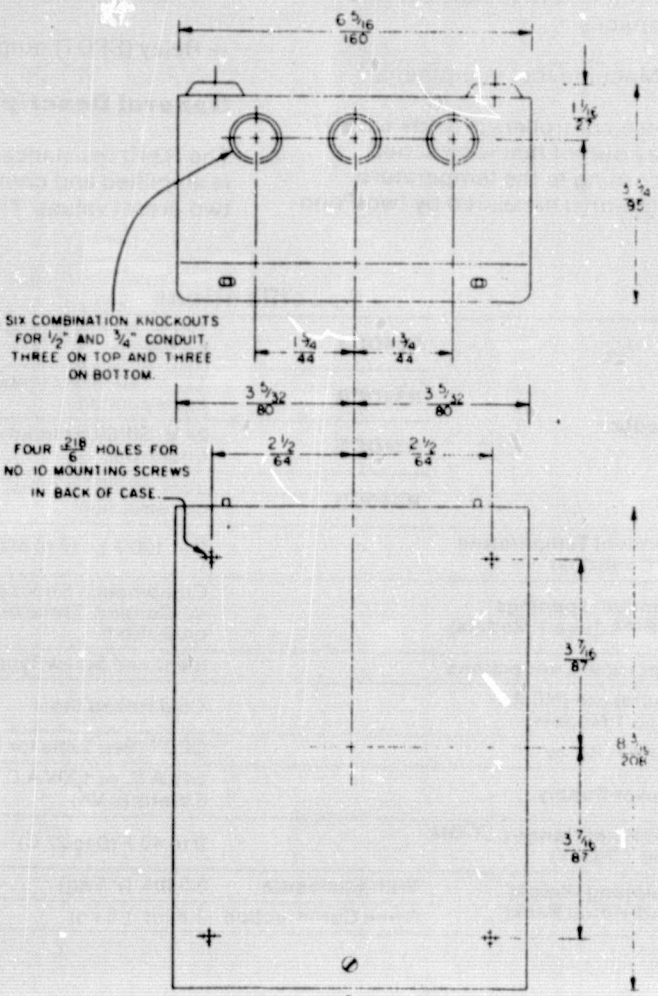


Fig. 4—Drawing of typical solar domestic hot water system.



R34D Dimensions $\frac{\text{in}}{\text{mm}}$

PENN BASO

PENN CONTROLS
DIVISION OF JOHNSON SERVICE COMPANY

INSTALLATION AND OPERATION INSTRUCTIONS

SERIES A41

FORM 996-104

TYPE A41W SOLID STATE SENSOR

For Use With Series R34 Controller

APPLICATION

This sensor is used with Series R34 differential temperature controllers on solar heating applications. It has a nickel wire wound element. Temperature coefficient is 3 ohms per degree Fahrenheit. For temperatures from −40° F (−40° C) to 350° F (177° C) with a resistance of 1000 ohms ± 1% at 70° F (21° C). If corrosive solutions are used, the Type A41W sensor should be installed in a stainless steel bulb well.

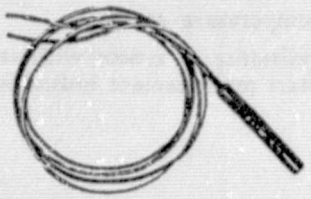


Fig. 1 — Type A41W sensor.

INSTALLATION

Locate the collector and storage facility sensors where good thermal contact to the controlled medium is maintained. To improve sensitivity, a small amount of a thermal conducting compound such as GE insulgrease #640 can be used between the sensor and collector panel and in the bulb well used in the storage tank.

Locating and Mounting

Collector Panel Sensor: Determine the best sensor location and secure in place. Generally, the collector sensor should be mounted on a part of the collector panel which will be directly heated by solar input. However, it should be near the collector outlet so the sensor is also sensing the outlet water temperature.

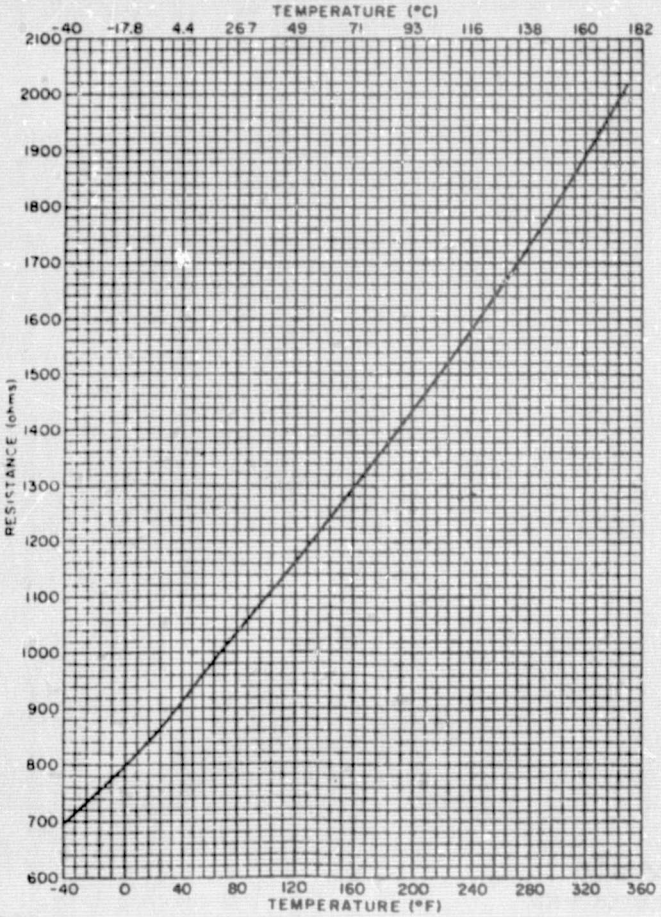


Fig. 2 — Temperature vs. resistance graph.

Storage Tank Sensor: Lower the liquid level and install the selected bulb well, preferably about midway between the top and bottom of the tank. Loosen set screws and remove bushing. Place a small amount of thermal compound in the well and insert the sensor. Insert the bushing, when used, and secure in place.

When hot rocks or other non-liquid storage facilities are used, locate sensor so the storage mediums average temperature is being sensed.

Wiring

> CAUTION: Disconnect power supply before wiring and mounting connections are made to prevent electrical shock and possible damage to the equipment.

All wiring must be in accordance with local regulations and the National Electrical Code.

> CAUTION: Make all wiring connections and check for correctness before applying power. Improper wiring may cause permanent damage.

Make wiring connections to the No. 18 AWG wire leads. Use No. 18 wire for lengths up to 50 feet. No. 14 wire should be used for runs up to 250 feet. Splices should be made with wire nuts or by soldering and taping.

CHECKOUT PROCEDURE

When components are installed and wiring is completed, recheck the wiring and apply power.

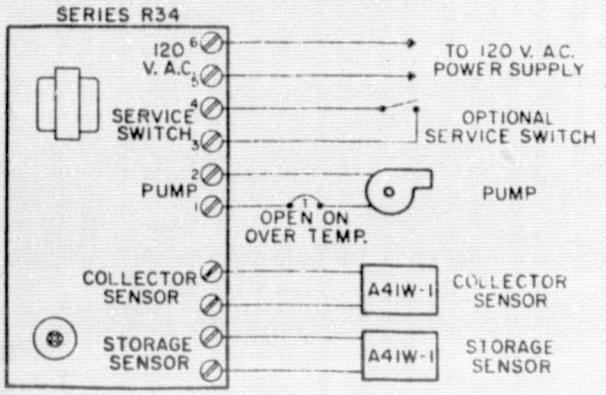


Fig. 3 — Typical wiring diagram.

Before leaving the installation, a complete operating cycle should be observed to see that all components are functioning properly.

Sensor Checkout

If system does not operate, use Series R34 installation checkout procedure from Form 996-94. If faulty sensor(s) is suspected proceed as follows:

1. Disconnect sensor wires.
2. Measure temperature at sensor.
3. Measure resistance of sensor with an ohmmeter. An open or short measurement indicates a bad sensor.
4. Check temperature measured in Step 2 and resistance measured in Step 3 against the graph curve in Figure 2.
5. Replace sensor if it is defective.

REPAIRS AND REPLACEMENT

Field repairs must not be made. Replacement sensors may be obtained from the nearest Penn Commercial or Systems Wholesaler. When ordering a replacement sensor, specify Product Number shown on the sensor.

Penn Division
Johnson Controls, Inc.
1201 West Crosby Road, Carrollton, TX 75006

Printed in U.S.A.

4-5-76

NUMBER
IS 300-3-1

EFFECTIVE: 2/1/73
SUPERSEDES: IS 300-3-1
dtd. 3/31/68

MAINTENANCE AND SERVICING

Plant ID. No. 001-359

C1-GENERAL

Before undertaking any service work on the pump, read these instructions carefully to be readily prepared for the job. For your convenience TACO encloses with these instructions a list of replacement parts for each pump. Order parts required for maintenance work by listing item number, number required, description, and part number. Before taking pump apart, flange gaskets for pipe connections and a pump gasket kit should be available.

A step by step procedure of the most common maintenance jobs is given below. Follow it on the exploded views in the replacement parts list. In the description and on the drawings all parts are referred to by item numbers. To start any maintenance work stop pump and close suction and discharge lines. To gain access to internal parts of pump remove flanged nipple (spool piece) that has been provided on suction side of the pump.

If no freely removable piece is provided on suction side of pump, you can service the pump by disconnecting both suction and discharge flanges and removing the frame hold down bolts. The whole pump can now be moved for convenient servicing.

C2-REPLACING IMPELLER

Required replacement parts

Item No. 6	Impeller
Item No. 3	Suction Cover "O" Ring
1 Pair of	Pipe flange gaskets

DISASSEMBLY

Disconnect suction cover (1) by removing suction cover bolts (2).

Remove impeller bolt (4) with a socket or offset box wrench. Bolt has right hand thread. Place wrench over bolt head, hold wrench handle horizontally and hit handle end sharply with a plastic hammer. This should loosen bolt (Fig. 2). If this method is unsuccessful hold exposed section of motor shaft with a pipe wrench.

Remove Belleville Washer (66), impeller washer (5) and impeller spacer (18) (where used) together with impeller bolt (4).

Pull out impeller (6) and impeller key (7). The use of a wheel puller may be helpful in removing the impeller. If no wheel puller is available, insert impeller bolt (4) in shaft (42) and bring bolt head down on it. Hold a drift against the bolt head and hit it 2 or 3 times sharply with a hammer. This will normally loosen impeller from shaft (Fig 3). Next insert two screwdrivers, one on each side in the grooving of the impeller wear rings and pry out, taking care not to damage the wear rings (Fig. 4). If any burrs develop smooth out with emery cloth.

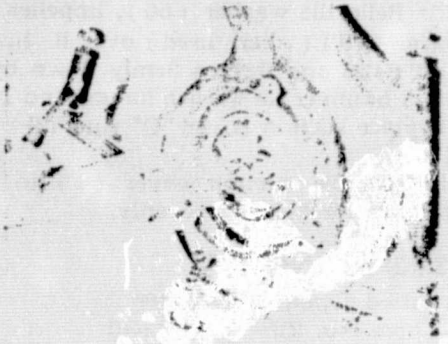
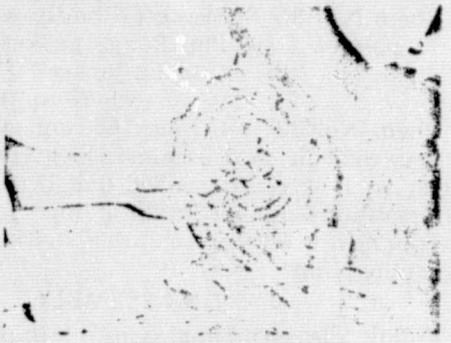


Fig. 1 — Disassembly



Reassembly

Fig. 2 Removing and Replacing Impeller Bolt

Fig. 3—Hitting on Drift—Impeller Bolt

Fig. 4 — Prying Out of Impeller

C2-REPLACING IMPELLER -Continued

REASSEMBLY

Clean shaft end (42) and key slot. Apply some grease or oil and insert key in key way.

Apply grease to wear rings on both sides of replacement impeller (6) and slide over shaft end.

Apply grease or oil to the threads of impeller bolt (4), slide Belleville washer (66), impeller washer (5) and spacer (18) (where used) over it. Insert bolt (4) into shaft (42) and tighten firmly down by hitting sharply with a hammer on wrench handle end (Fig. 2).

Replace suction cover "O" ring (3) on suction cover (1).

Reassemble suction cover (1) to casing (8) and tighten cover bolts (2) evenly.

C3-REPLACING SEAL

Required replacement parts

Item No. 29	Waterseal
Item No. 90	Gasket Kit
Item No. 9	Impeller Spacer (if badly worn)
Item No. 35	Sleeve (if badly worn)
1 pair of	Pipe flange gaskets
Item No. 26	Cooling jacket "O" ring (where applicable)
Item No. 33	Casing "O" ring (where applicable)

It is difficult to determine which concealed parts are worn so it is recommended that if the pump has been in operation for some length of time that these concealed parts (item 9 & item 35) are also available before dismantling pump.

DISASSEMBLY

Follow disassembling steps of impeller replacement, paragraph C 2. Disconnect (where applicable) cooling jacket (27) pipe connections. Remove seal retainer cap bolts (30) with a ratchet type socket wrench. On larger models a 12 point box wrench may also be used. Tap seal retainer cap (32) to loosen it and slide it back on the shaft.

Remove casing (8) from frame (15) by taking casing bolts (16) out. Cooling jacket (27) (where used) will slide out with casing (8). Pry cooling jacket (27) off casing (8) by inserting screwdrivers in the casing "O" ring (33) slot. Slide impeller spacer (9), sleeve (35) with waterseal (29) on it, sleeve gasket (67) and seal retainer cap (32) off the shaft (42).

Remove spring retainer ring and spring of the seal from sleeve (35). To remove rotating seal part from sleeve, place sleeve (35) chamfered side down on a horizontal surface, slide seal retainer cap (32) over top of sleeve (35) and push down with both hands (Fig. 5).

Remove stationary seal seat from seal retainer cap (32). cap (32).

Discard old seal parts (29), sleeve gasket (67) and paper cap gasket (28). Discard also impeller spacer (9) and sleeve (35) if badly worn. Where cooling jacket is used, replace casing—and cooling jacket "O" rings (26,33).

REASSEMBLY

Clean, if necessary, with fine emery cloth, exposed shaft end (42), sleeve (35), impeller spacer (9) and seal retainer cap (32). Clean also portions of casing (8) which came in contact with seal (29) and throttle bushing (10) which is pressed into casing.

Place new seal seat in seal retainer cap (32). For ease of assembly, wet O.D. of seat with water. Hold the seal retainer cap (32) with both hands and press down on the seat with thumbs. Push alternately left and right hand side (Fig.6). Another method of placing the seat is to put the cardboard disc of the seal packaging on the top of the seal seat and then push down on it with a hammer handle (Fig.7). After the seat is placed on the seal retainer cap (32), check on the back side to see that the seal seat is properly seated against the seal retainer cap shoulder.

Apply some grease or oil to exposed shaft end (42). Slide sleeve gasket (67) and sleeve (35) over shaft. Chamfered side of sleeve should point toward impeller end (Fig.8). Place cap gasket (28) on seat retainer cap (32) and accurately line up bolt holes. Two drops of oil or grease on the contact face of the cap and gasket will hold these parts temporarily together. Slide seal retainer cap (32) with seal seat and cap gasket (28) over the sleeve (35) as far as it will go. Be careful not to damage seal seat.

Wet I.D. of rotating seal part (29 rubber) with water. Slide it, carbon washer facing seal seat, over sleeve. (35) Push seal (29) all the way back until it gently touches the seat. Slide the seal spring over the sleeve followed by the spring retainer ring with the raised portion toward the spring (Fig.8),

Clean—where applicable—cooling jacket (27) and replace "O" rings (26 & 33). Place cooling jacket over back of casing (8).

Assemble casing (8) to frame (15) and firmly tighten casing bolts (16) alternately.

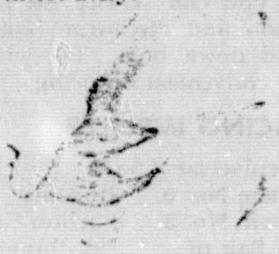


Fig. 5 — PRESSING SEAL OFF SLEEVE

Fig. 6— PRESSING IN SEAL SEAT

Fig. 7—PRESSING IN SEAL SEAT WITH HAMMER HANDLE

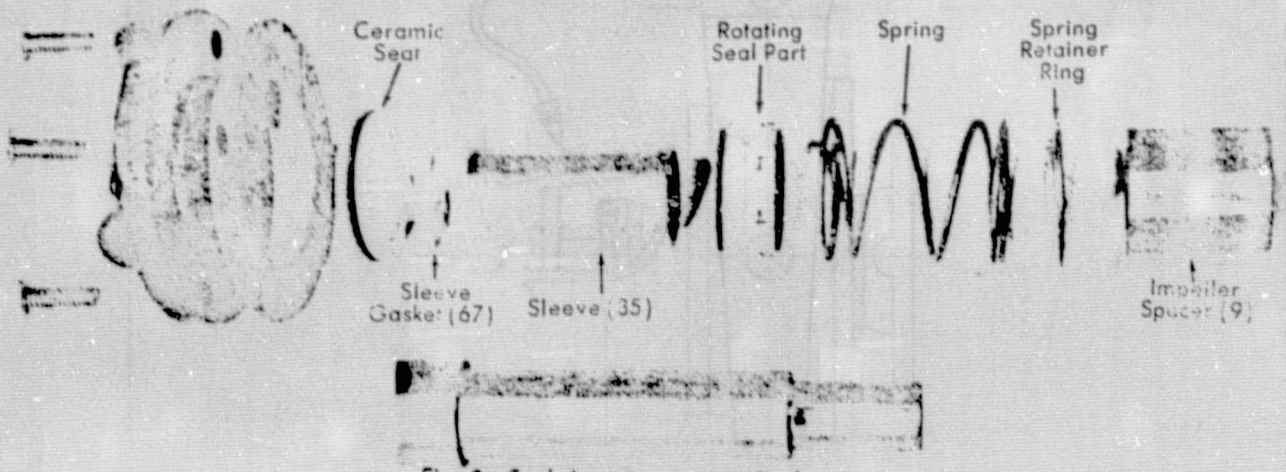


Fig. 8—Seal Arrangement on Shaft

C3—REPLACING SEAL-Continued

Place impeller spacer (9) on shaft (42) it will fit the space between throttle bushing (10) and shaft. Next follow reassembly directions for impeller.

Before reassembling suction cover (1) insert the two side cap bolts (30) through seal retainer cap (32) and cap gasket (28) and slide them towards rear end of casing (8) (Fig. 9). Start bolts in threaded holes and take up cap evenly by turning bolt (30) alternately on each side. Do this operation very carefully in order not to break seal. When cap reaches casing (8) insert also top and bottom bolt (30) and tighten all four alternately and evenly.

Reconnect (where applicable) cooling jacket (27) pipe connections.

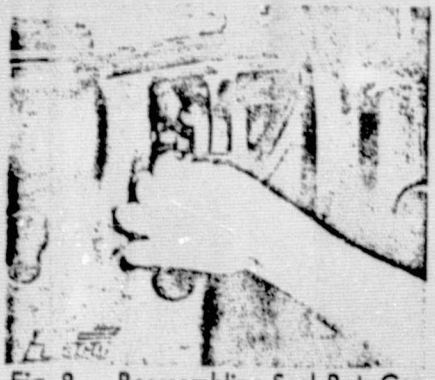


Fig. 9 — Reassembling Seal Ret. Cap

C4-REPLACING PACKING

Remove packing gland nuts (24) and slide gland (23) back as far as it will go.

Remove all old packing rings (20) with a flexible packing hook or one made from a piano wire with a short sharp hook.

Replace with graphite impregnated asbestos rings by a reliable packing manufacturer. Packing ring sizes are as follows:

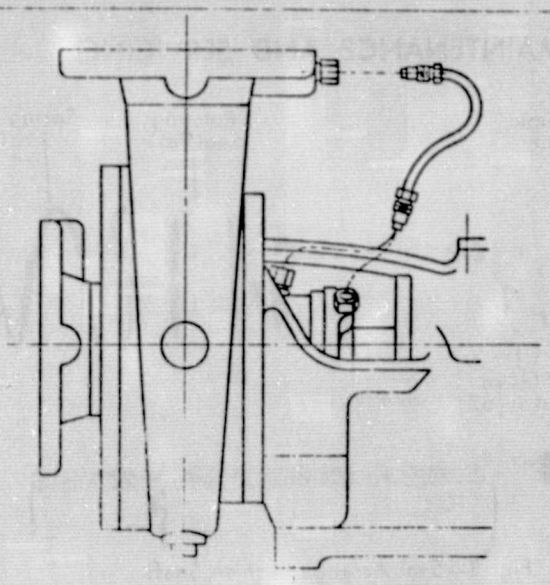
PUMP SIZE	NO. OF RINGS	RING SIZE
		I.D. O.D. Thickness
1¼-5, 1¼-6, 1½-5 1½-6, 1½-3, 2-5, 2-6 2½-5, 2½-6, 3-5, 3-6	4	1¼"x1¾"x⅜"
2-8, 2½-8, 2½-10, 3-8 4-6	5	1¼"x2" x ⅜"
3-10, 4-8, 4-10, 4-12, 5-8 5-10, 5-12, 6-10	6	1½"x2¼"x ⅜"
6-12	5	2" x 3" x ½"

Solid rings should be split diagonally on one side. If a length of spiral packing is used, rings should be cut to ID's as shown above. Butts at joints should be made diagonally.

After rings (20) are ready to use, open first ring sufficiently to place around shaft (42) with opening at bottom and push into stuffing box chamber with the packing gland (23). Next, pull gland (23) back and insert next ring (20) with opening on top and again push into place with gland (23). Repeat this operation. alternating cuts in rings for the required number.

Slide gland (23) squarely up to the last packing ring (20) and hand tighten nuts (24) (Do not use a wrench at this time). Open discharge and suction valves. If packing does not leak or leaks slightly, pump may be started. If packing leaks excessively, tighten nuts (24) with a short wrench one or two turns, before starting pump. Permit more than normal (1 to 3 drops, per minute) leakage while pump is running for approximately 30 to 60 minutes. During this running in period, take up on the nuts (24) equally about one half (1/2) turn every five (5) minutes or so until at the end of the period you are getting a normal leak of 1 to 3 drops per minute. While pulling up on the nuts (24), make certain the gland (23) is being pulled up evenly.

INSTALLATION OF EXTERNAL CIRCULATION TUBE

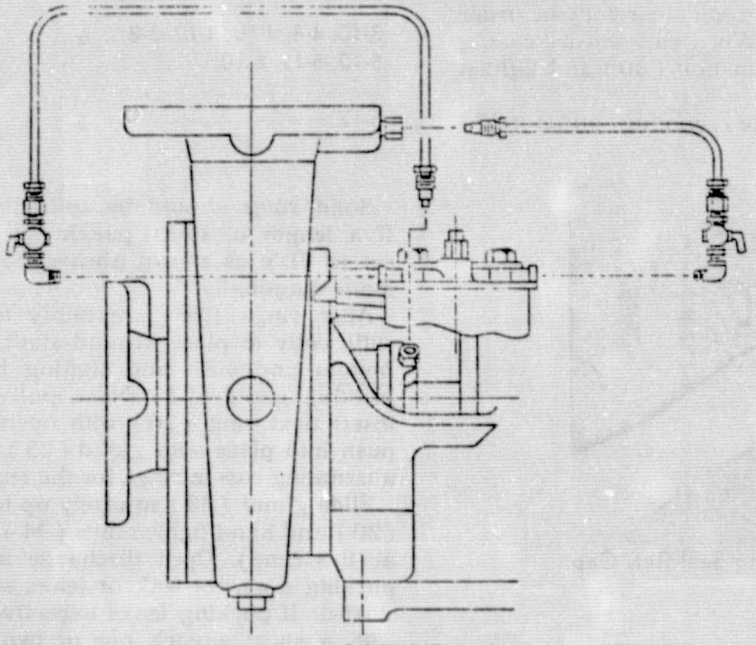


IMPORTANT

Before filling system with water assemble external circulation tube to pump casing as follows:

1. Screw nut into body until hand tight.
2. With a wrench continue tightening for about one and one-half full additional turns. (It is not necessary to tighten nut all the way down)

INSTALLATION OF PUROCELL FILTER



IMPORTANT

1. Attach Filter to the pump by loosening the top bolt on the frame and casing and slip bracket under bolt and tighten.
2. If Recirculating line is installed — remove from frame and insert this end into inlet of Filter.
3. Attach line from outlet of the filter to seal retainer cap.

TACO, INC.
1160 Cranston Street, Cranston, Rhode Island 02920 Printed in U.S.A.

Taco

REPLACEMENT PARTS LIST

NUMBER
300PL2

Effective: December 1, 1976
Supersedes: 300PL2, 7/30/75

FOR FOLLOWING MODEL NOS.

BM or CC: 2-5 2-6 2½-5 2½-6 3-5 and 3-6
BM or CC: 2005 2006 2505 2506 3005 and 3006
SB or BB: 2005 2006 2505 2506 3005 and 3006

REPLACEMENT PARTS FOR:
Close Coupled (CC) Pumps • Base Mounted (BM) Pumps
Sleeve Bearing (SB) Pumps • Ball Bearing (BB) Pumps

WHEN SELECTING AND ORDERING PARTS, ALWAYS REFER TO SERIAL NUMBER ON NAME PLATE

—Example—

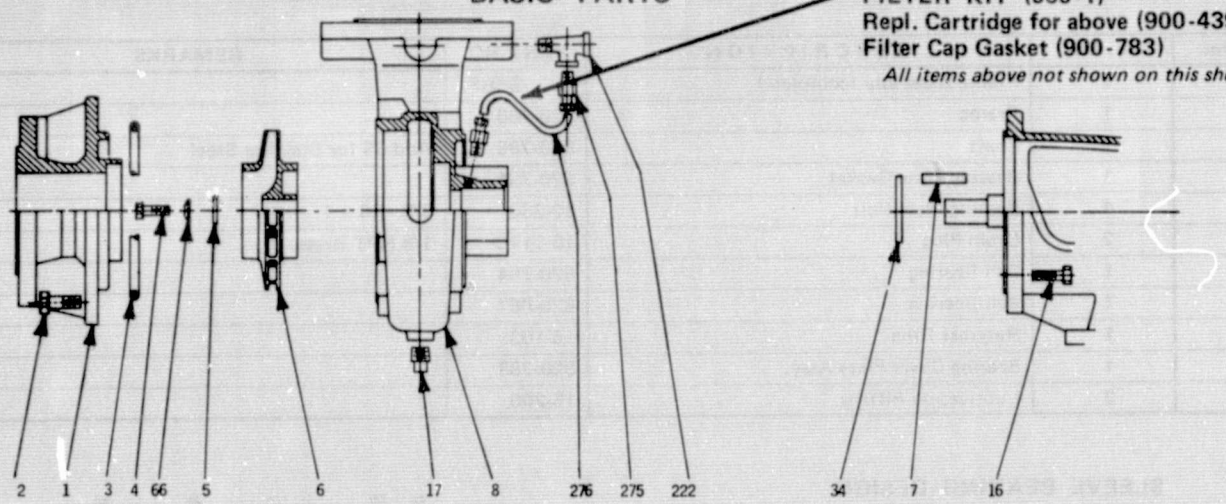
p. 1 ACTUAL IMPELLER DIAMETER
NOMINAL IMPELLER DIAMETER
FRAME SIZE & STYLE p. 2

2 - 6 - 5.9 — A1B1
OR
2006 - 5.9 — A5B1

p. 2 FRAME SIZE & STYLE
SEAL OR PACKING DESIGN p. 3

BASIC PARTS

FILTER KIT (900-1)
Repl. Cartridge for above (900-439)
Filter Cap Gasket (900-783)
All items above not shown on this sheet.



Item No.	No. Reqd.	DESCRIPTION	PART NO. PER PUMP SIZE						REMARKS
			2 - 5 2005	2 - 6 2006	2½ - 5 2505	2½ - 6 2506	3 - 5 3005	3 - 6 3006	
1	1	Suction Cover	917-003*	918-003	925-003*	926-003	930-003*	932-003	Add "B" after No. for Bronze
2		Suction Cover Bolt	10-230(4)	10-230(8)	10-230(4)	10-230(8)	10-230(4)	10-230(8)	3/8 - 16 x 1
3	1	Suction Cover 'O' Ring	903-005	918-005	903-005	918-005	903-005	918-005	
4	1	Impeller Bolt (SS)	10-258A	10-258A	N/A	N/A	N/A	N/A	3/8 - 16 x 5/8 St. Steel
4	1	Impeller Bolt (SS)	N/A	N/A	10-254A	10-254A	10-254A	10-254A	3/8 - 16 x 7/8 St. Steel
5	1	Impeller Washer	900-008	900-008	926-004	926-004	926-004	926-004	
6	1	Impeller	917-002*	918-002	925-002*	926-002	930-002*	932-002	Add "B" after No. for Bronze
7	1	Impeller Key (SS)	13-107A	13-107A	N/A	N/A	N/A	N/A	3/16 x 3/16 x 3/4 St. Steel
7	1	Impeller Key (SS)	N/A	N/A	13-105A	13-105A	13-105A	13-105A	3/16 x 3/16 x 1-1/8 St. Steel
8	1	Casing (1)	917-001*	918-001	925-001*	926-001	930-001*	932-001	Add "B" after No. for Bronze
16	4	Casing Bolt	10-201	10-201	10-201	10-201	10-201	10-201	3/8 - 16 x 1-1/8
17	1	Drain Plug	16-102	16-102	16-102	16-102	16-102	16-102	3/8 NPT Steel
18	1	Spacer	900-007	900-007	N/A	N/A	N/A	N/A	
34	1	Slinger Ring	900-040	900-040	900-040	900-040	900-040	900-040	For Close Coupled Only
34	1	Slinger Ring	900-044	900-044	900-044	900-044	900-044	900-044	For Base Mounted Only
66	1	Belleville Washer	900-053	900-053	900-053	900-053	900-053	900-053	
222	1	Fitting	900-566	900-566	900-566	900-566	900-566	900-566	
275	2	Fitting	900-798	900-798	900-798	900-798	900-798	900-798	
276	1	Tube	900-728	900-728	900-728	900-728	900-728	900-728	

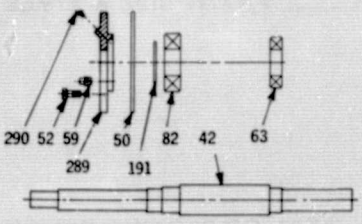
(1) Throttle Bushing (Item 10) found in Seal Section must be ordered with each casing.
* No longer available, consult factory for replacement

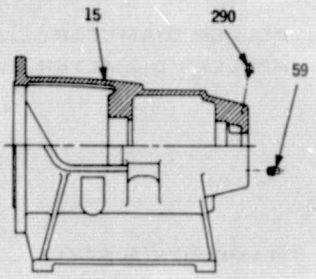
TACO, Inc., 1160 Cranston Street, Cranston, Rhode Island 02920 U.S.A. Tel: (401) 942-8000 Telex: 92-7627
Litho in USA

FRAME SIZE & STYLE – 0000-00-XX00

A1	BALL BEARING DESIGN:	Update pump with 820-795RP Complete frame assembly. Please furnish all nameplate data to insure proper updated nameplate.
A2	SLEEVE BEARING DESIGN:	Update pump with 820-797RP Complete frame assembly. Please furnish all nameplate data to insure proper updated nameplate.
A3	SLEEVE BEARING DESIGN:	Update pump with 820-797RP Complete frame assembly. Please furnish all nameplate data to insure proper updated nameplate.

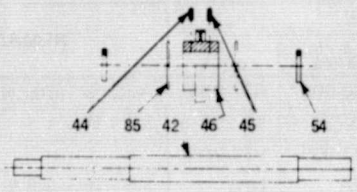
A5 BALL BEARING DESIGN:

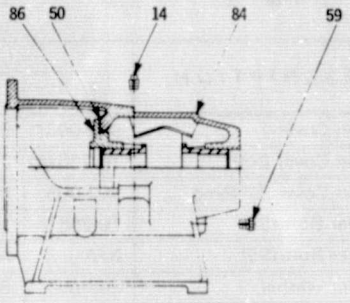




Item No.	No. Req.	DESCRIPTION	PART NO.	REMARKS
74	1	Frame Assembly (complete)	820-795RP	
15	1	Frame	820-786	
42	1	Shaft	820-785	Add SS for Stainless Steel
50	1	Bearing Plate Gasket	820-791	
52	4	Bearing Plate Bolt	10-230	3/8 - 16 x 1
59	2	Drain Plug	16-111C	1/8 NPT Brass
63	1	Ball Bearing	820-784	
82	1	Ball Bearing	820-067	
191	1	Retainer Ring	15-103	
289	1	Bearing Cover Plate Assy.	820-788	
290	2	Lubrication Fitting	15-200	

A6 SLEEVE BEARING DESIGN:

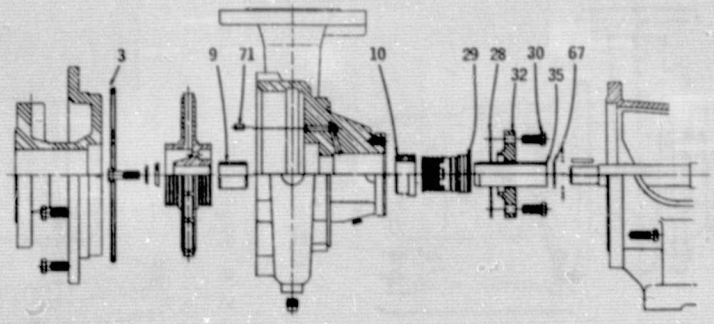




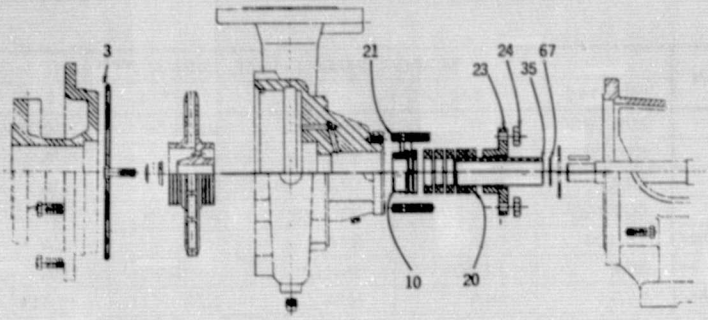
Item No.	No. Req.	DESCRIPTION	PART NO.	REMARKS
74	1	Frame Assembly (complete)	820-797RP	
14	1	Pipe Plug	16-102	3/8 NPT Steel
42	1	Shaft	820-048	
44	1	Cone Point Set Screw	10-310	5/16 - 18 x 3/8 Steel
45	1	Cup Point Set Screw	10-301	5/16 - 18 x 5/16 Steel
46	1	Thrust Collar	820-423	
50	1	Bearing Plate Gasket	820-791	
54	1	Oil Seal	840-129	
59	1	Drain Plug	16-111C	1/8 NPT Brass
84	1	Frame Sub Assembly	820-798	
85	2	Thrust Washers	820-052	
86	1	Bearing Support Assembly	820-058	

SEAL OR PACKING DESIGN – 0000-00-00X0

MECHANICAL SEAL



PACKING



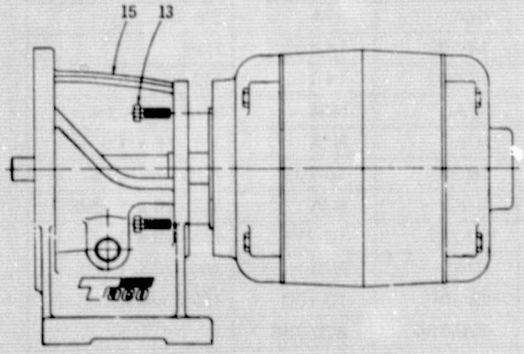
TYPE B STANDARD. TYPE D HI-TEMP. TYPE P PACKED. TYPE E CERAMIC.

Item No.	No. Reqd.	DESCRIPTION	SEAL OR PACKING DESIGN			REMARKS
			Type "B"	Type 'D'	Type 'P'	
3	1	Suction Cover 'O' Ring		*See Page 1*		
9	1	Impeller Spacer	900-026	900-026	Not Used	
10	1	Throttle Bushing	900-009	900-009	903-009	
20	1	Packing Set			900-240	
22	1	Filler Ring (Not shown)	Not Used	Not Used	905-007	
23	1	Gland			903-008	Add Suffix 'B' for Bronze
24	2	Hex Nuts			12-129	3/8 - 16
28	1	Retainer Cap Gasket	900-011	900-011		
29	1	Water Seal (1)	900-024	900-087		
91	1	WATER SEAL KIT (1)	840-128BRP	840-128DRP	Not Used	Incl. Items 28, 29, 35 & 67
30	4	Retainer Cap Bolts	10-208	10-208		3/8 - 16 x 7/8
32	1	Seal Retainer Cap	900-025	900-025		
35	1	Sleeve	900-027B	900-027B	920-006	
67	1	Sleeve Gasket	920-007	920-007	920-007	
21	2	Stud	Not Used	Not Used	900-029	

(1) For Ceramic Seal, order 900-215 or 840-128 ERP Kit.

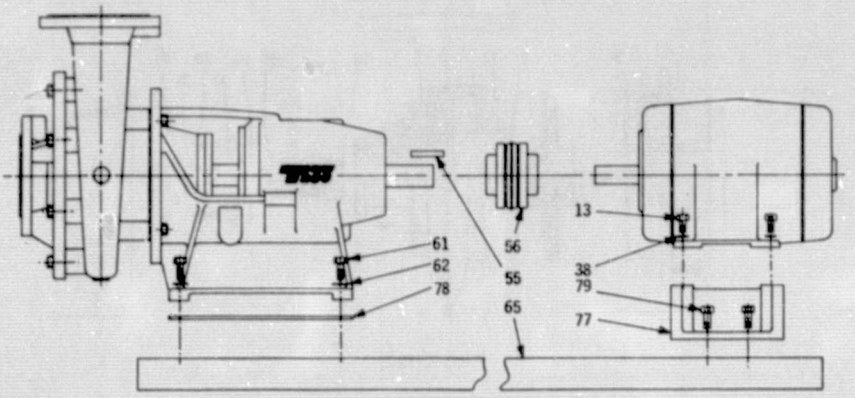
CLOSE COUPLED (CC)

CC FRAMES ---------- A4



NEMA FRAME Size "T"	NEMA FRAME Size "U"	ITEM 13 FR. BOLT Part No.	ITEM 13 FRAME BOLT Size	ITEM 15 PUMP FRAME
	48	10-201	(4) 3/8 - 16 x 1–1/8	900-001
	56	10-201	(4) 3/8 - 16 x 1–1/8	900-001
143	182	10-201	(4) 3/8 - 16 x 1–1/8	900-001
145	184	10-201	(4) 3/8 - 16 x 1–1/8	900-001
182	213	10-201	(4) 3/8 - 16 x 1–1/8	900-001
184	215	10-201	(4) 3/8 - 16 x 1–1/8	900-001
213	254	10-201	(4) 3/8 - 16 x 1–1/8	900-001
215	256	10-201	(4) 3/8 - 16 x 1–1/8	900-001

MOTOR PARTS – NOT PART OF SERIAL NUMBER
–Motor Frame Sizes Must be Specified When Ordering Parts Shown Below–



Item No.	No. Reqd.	DESCRIPTION	MOTOR FRAME SIZE (NEMA STD.) 'T'						REMARKS
			143–145	182	184	213–215	254	256	
65	1	Base Plate (1)	820-090	820-090	820-090	820-109	820-109	820-109	Steel
77	2	Spacer	820-098	820-003	820-004	N/A	N/A	N/A	
78	2	Frame Spacer	N/A	N/A	N/A	N/A	N/A	N/A	
56	1	Coupler	900-193	900-206	900-206	900-195	900-197	900-197	
38	4	Motor Lock Washer	14-104	N/A	N/A	N/A	N/A	N/A	5/16
38	4	Motor Lock Washer	N/A	14-101	14-101	14-101	N/A	N/A	3/8
38	4	Motor Lock Washer	N/A	N/A	N/A	N/A	14-100	14-100	7/16
62	4	Frame Lock Washer	14-102	14-102	14-102	14-102	14-102	14-102	1/2
13	4	Motor Hex. Hd. Bolt	10-251	N/A	N/A	N/A	N/A	N/A	5/16 - 18 x 1¼
13	4	Motor Hex. Hd. Bolt	N/A	10-221	10-221	10-221	N/A	N/A	3/8 - 16 x 1¼
13	4	Motor Hex. Hd. Bolt	N/A	N/A	N/A	N/A	10-202	10-202	7/16 - 14 x 1¼
61	4	Frame Hex. Hd. Bolt	10-238	10-238	10-238	10-238	N/A	N/A	1/2 - 13 x 1–5/8
61	4	Frame Hex. Hd. Bolt	N/A	N/A	N/A	N/A	10-217	10-217	1/2 - 13 x 2½
79	4	Spacer Hex. Hd. Bolt	10-230	10-230	10-230	N/A	N/A	N/A	3/8 - 16 x 1
55	1	Coupler Key	13-100	13-100	13-100	13-100	13-100	13-100	1/4 x 1/4 x 1½
47	1	Coupler Guard	820-796	820-796	820-796	820-796	820-796	820-796	
48	4	C.G. Rd. Hd. Screw	10-400	10-400	10-400	10-400	10-400	10-400	1/4 - 20 x 3/8
111	1	Coupler Insert	900-512	900-512	900-512	900-513	900-514	900-514	

(1) Add "A" to base plate number when coupler guard is to be used

Item No.	No. Reqd.	DESCRIPTION	MOTOR FRAME SIZE (NEMA STD.) 'U'						REMARKS
			56	182	184	213–215	254	256	
65	1	Base Plate (1)	820-090	820-090	820-090	820-109	820-109	820-109	Steel
77	2	Spacer	820-103	820-003	820-004	N/A	N/A	N/A	
78	2	Frame Spacer	N/A	N/A	N/A	N/A	N/A	N/A	
56	1	Coupler	900-192	900-193	900-193	900-206	900-195	900-195	
38	4	Motor Lock Washer	14-104	N/A	N/A	N/A	N/A	N/A	5/16
38	4	Motor Lock Washer	N/A	14-101	14-101	14-101	N/A	N/A	3/8
38	4	Motor Lock Washer	N/A	N/A	N/A	N/A	14-100	14-100	7/16
62	4	Frame Lock Washer	14-102	14-102	14-102	14-102	14-102	14-102	1/2
13	4	Motor Hex. Hd. Bolt	10-251	N/A	N/A	N/A	N/A	N/A	5/16 - 18 x 1¼
13	4	Motor Hex. Hd. Bolt	N/A	10-221	10-221	10-221	N/A	N/A	3/8 - 16 x 1¼
13	4	Motor Hex. Hd. Bolt	N/A	N/A	N/A	N/A	10-202	10-202	7/16 - 14 x 1¼
61	4	Frame Hex. Hd. Bolt	10-238	10-238	10-238	10-238	N/A	N/A	1/2 - 13 x 1–5/8
61	4	Frame Hex. Hd. Bolt	N/A	N/A	N/A	N/A	10-217	10-217	1/2 - 13 x 2½
79	4	Spacer Hex. Hd. Bolt	10-230	10-230	10-230	N/A	N/A	N/A	3/8 - 16 x 1
55	1	Coupler Key	13-100	13-100	13-100	13-100	13-100	13-100	1/4 x 1/4 x 1½
47	1	Coupler Guard	820-796	820-796	820-796	820-796	820-796	820-796	
48	4	C.G. Rd. Hd. Screw	10-400	10-400	10-400	10-400	10-400	10-400	1/4 - 20 x 3/8
111	1	Coupler Insert	900-512	900-512	900-512	900-512	900-513	900-513	

(1) Add "A" to Base Plate Number when Coupler Guard is to be used.

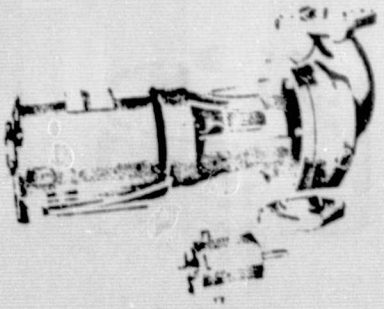
TACO

INSTRUCTION SHEET
NUMBER
IS-300-1-12

ALL CARTRIDGE-TYPE CIRCULATORS: 2½", 3", AND 1600 SERIES (-9 AND UP)

EFFECTIVE: FEB. 1, 1968
Supersedes: IS-300-1-12 Dated Sept. 11, 1967
REVISED: August 15, 1971

Plant ID. No. 001-329



APPLICATION:

All pumps covered by this instruction sheet are designed for pumping water.

Working Pressure:	Up to 175 PSIG in accordance with ASA B16.1.
Temperature:	250° F Standard 300° F with Hi-Temp Seal

INSTALLATION:

Install *horizontally only* and with the *longer of the two bracket ribs pointing to the ceiling.*

The casing can be rotated relative to the bracket for installation in vertical or horizontal pipe.

The pump must be installed far enough away from ceiling and walls to permit lubrication of bracket and motor.

"CAUTION": UNDER NO CIRCUMSTANCES SHOULD ANY PART OF BRACKET OR MOTOR BE COVERED WITH INSULATION.

START UP:

Before operating the pump for the first time check the following:

1. Is motor correctly wired for voltage in use?
   Warranty is void if motor is damaged due to improper electrical hook-up.
2. If a magnetic starter is used see that the heater element is sized for the Service Factor load of the motor otherwise nuisance tripouts may occur.
3. Motor and pump are properly oiled at the factory. However, as a matter of precaution it is recommended that the oil level in the pump bracket be checked as specified on pump nameplate. An oil level slightly above the "full" mark on the dip stick can be tolerated.
4. Motors are properly aligned with pump at the factory and normally require no attention. If due to rough handling the motor base becomes bent, realign by shimming between cast iron and steel section of motor base.
5. Before starting motor, ascertain that pump is filled with water to lubricate the seal. *Do not operate pump dry for motor checkout.*

LUBRICATION:

Pump must never be operated with oil level in bracket below low limit on dip stick.

For replenishing, use premium grade SAE No. 30 oil only (see pump nameplate).

Lubricate motor per instruction label attached to motor.

aco ..ers of Canada, Ltd.
3090 Lenworth Drive
Cooksville, Ontario

TACO, INC. 1160 Cranston Street, Cranston, Rhode Island 02920

FIGURE 1

FIGURE 2

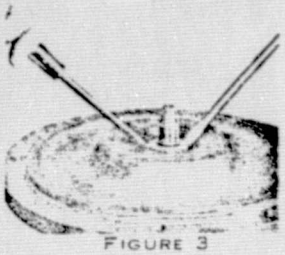


FIGURE 3

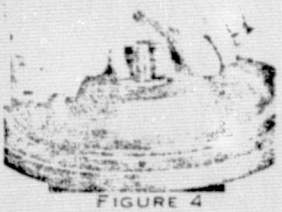


FIGURE 4

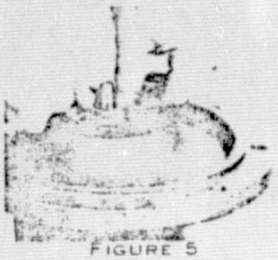


FIGURE 5

FIGURE 6

FIGURE 7

SEAL REPLACEMENT:

To replace the water seal, the following steps must be observed:

1. Disconnect electrical connections. Relieve system pressure and drain water from body.
2. Remove motor assembly from bracket and bracket from pump body.
3. Place bracket in vertical position, impeller up and loosen screw at center of impeller two turns. (7/16 Hex Head) *This screw has a left-hand thread.* Tap impeller at its outside diameter with handle of hammer to free tapered fit between shaft and impeller and completely remove screw, washer and impeller. (see Figure 2)
4. Remove carbon assembly and ceramic seal by prying them loose with a screwdriver. (see Figure 3)
5. If necessary, thoroughly clean shaft and seat cavity.
6. Insert new seal seat. For easy assembly coat OD of seal rubber (either a cup or an O-ring) with special grease provided in small container. Do not use any other oil or grease. Push seat *all the way down into cavity. Seat must not be cocked relative to shaft. Be sure face of seal stays absolutely clean — wipe surface with with soft clean cloth if necessary.* (see Figure 4)
7. Install new carbon assembly. Coat inside of rubber bellows with special grease provided (do not use any other oil or grease) and slide assembly (carbon first) over shaft until carbon meets seat. Push on rubber insert on very end of assembly and not on outside diameter of carbon retainer. *Be sure carbon face stays absolutely clean* (see Figure 5)
8. Install spring and spring retainer with raised face inside spring. (see Figure 6)
9. Replace impeller using new impeller screw and washer provided. Make sure cones of both impeller and shaft are clean.
10. Reassemble bracket into pump casing using new gasket provided. Clean gasket surface of both casing and bracket if necessary. *Be sure that the longer of the two outside bracket ribs is on top.* (see Figure 1)
11. Reinstall coupler and motor.
12. Follow procedure outlined under section Start Up where required.

IMPELLER REPLACEMENT:

Follow steps 1 through 3 and 8 through 12 outlined under section Seal Replacement.

BEARING (CARTRIDGE) REPLACEMENT:

If for some reason the bracket bearings should fail, it is not necessary to replace the entire bracket.

A pre-lubricated cartridge containing bearings and shaft is available. To change the cartridge, follow this procedure:

—Follow steps 1 through 4 as outlined under section Seal Replacement.

—Flip bracket around so that moter end is on top.

—Remove the two outermost socket head screws. (see Figure 7)

—Pull out old cartridge. If necessary tap cone end of shaft with a hammer to accomplish this.

—Insert new cartridge and refasten with socket head screws.

—Follow steps 5 through 12 outlined under section Seal Replacement.

Note: If you plan to re-use the water seal it is not necessary to remove the seal seat. The carbon assembly may be lubricated with water to make reinstallation easy. It is recommended that when changing the cartridge the water seal be replaced also.

Taco | REPLACEMENT PARTS

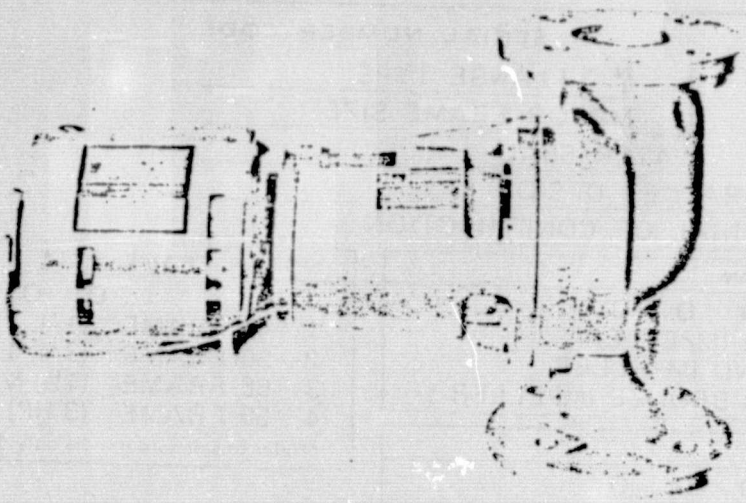
NUMBER
300-1PL-1

Effective: 12/1/76
Supersedes: 100-PL-15 and 300-1PL-1, both dated 2/11/74

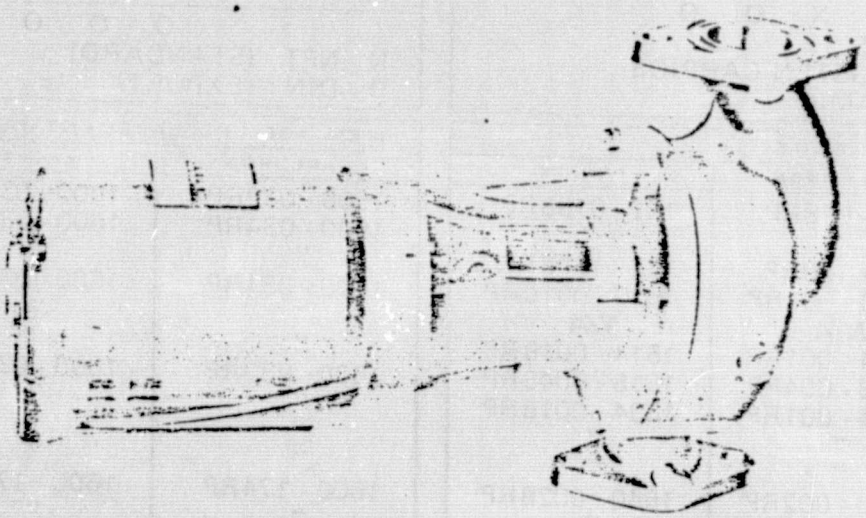
121 THRU 138 PUMPS
1600 SERIES PUMPS

IMPORTANT: When ordering, always specify part number, part name, and complete model number of pump.

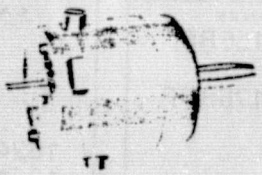
CARTRIDGE DESIGN PUMPS



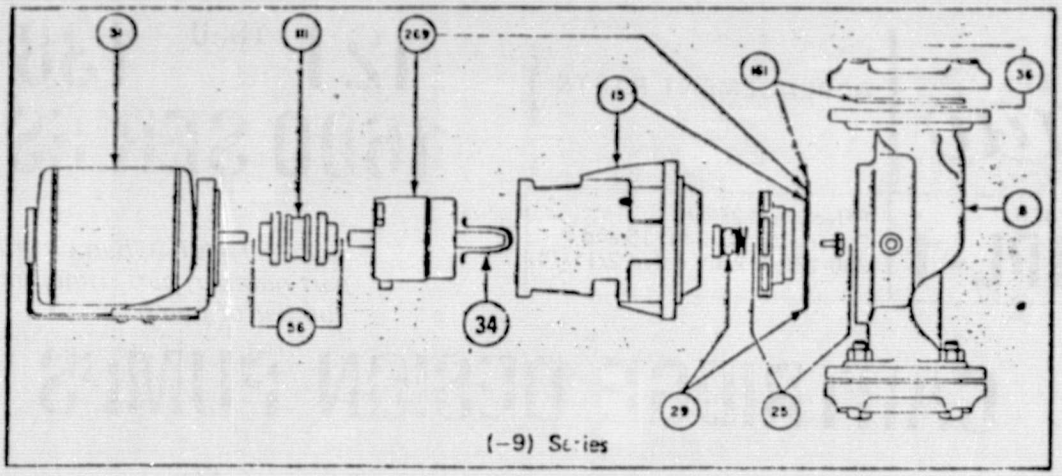
121 – 138 SERIES PUMPS



1600 SERIES PUMPS



Taco, Incorporated 1160 Cranston Street, Cranston, Rhode Island 02920 Telephone [401] 942-8000 Telex: 92-7627
Printed in U.S.A.
Taco Heaters of Canada, Ltd. 3090 Lenworth Drive, Mississauga, Ontario Telephone [416] 625-2160 Telex: 06 961179



(–9) Series

SERIAL NUMBER CODE

1600C - - - 4.25 C 1 N 1 N

- N — FLANGE TYPE
- 1 — MOTOR FRAME SIZE
- N — WATER SEAL
- 1 — BRACKET DESIGN
- C — MATERIAL OF CONSTRUCTION

MATERIAL OF CONSTRUCTION

X O O O O

A CAST IRON PUMP AND IMPELLER
B ALL BRONZE PUMP AND IMPELLER
C CAST IRON PUMP AND BRONZE IMPELLER

BRACKET DESIGN

O X O O O

ALL CURRENT STYLE PUMPS

WATER SEAL TYPE, ITEM #29

O O X O O

N 1600 - 170RP NI-RESIST
H 1600 - 170HRP TUNGSTEN CARBIDE
E 1600 - 170ERP CERAMIC

MOTOR FRAME SIZE*

O O O X O

1 48 FRAME (1/4, 1/3, 1/2 HP)
2 56 FRAME (3/4, 1 HP)
3 56 FRAME (1½, & 2 HP)
4 56 FRAME (3 HP)

*Refer to standard motors only. See nameplate for other motors.

FLANGE TYPE

O O O O X

N NPT (STANDARD)
D DIN (EXPORT)

ITEM #8 REPLACEMENT BODY

PUMP MOD. NO.	CAST IRON	BRONZE
121	121 - 018RP	121 - 018BRP
122	"	"
131, 32, 33 & 38[1]	133 - 150RP	133 - 150BRP
1600, 10, 11[1]	1610 - 001RP	1610 - 001BRP
1602, 1604[2]	*N/A*	*N/A*
1612, 14, 15	1614 - 001RP	1614 - 001BRP
1616, 18, 19	1618 - 004RP	1618 - 004BRP
1620, 22, 24	1634 - 001RP	1634 - 001BRP
1630, 1632	"	"
1634, 1635	"	"
1636, 1638	1640 - 002RP	1640 - 002BRP
1640, 1641	"	"

ITEM #36 REPLACEMENT FLANGE SET

CAST IRON	BRONZE
1600 - 033RP	1600 - 033BRP
1600 - 034RP	1600 - 034BRP
"	"
1600 - 031RP	1600 - 031BRP
"	"
"	"
1600 - 032RP	1600 - 032BRP
"	"
"	"
"	"
1600 - 174RP	1600 - 174BRP
"	"

ITEM #15 REPLACEMENT BRACKET

PUMP MOD. NO.	MOTOR FRAME SIZE (48)		MOTOR FRAME SIZE (56)		ITEM #161 GASKET KIT
	CAST IRON	BRONZE	CAST IRON	BRONZE	
121, 122	1600 - 155RP	1600 - 156RP			1600 - 050RP
1600, 10, 11	"	"			"
1602, 1604	1600 - 175RP	1600 - 176BRP			"
12, 20, 30	"	"			"
131, 132, 1615	"	"	1624 - 023RP	1624 - 024RP	"
133, 138	"	"	1624 - 023RP	1624 - 024RP	"
1614, 22, 24	"	"	"	"	"

ITEM #15 REPLACEMENT BRACKET (CONT.)					ITEM #161 GASKET KIT
PUMP MOD. NO.	MOTOR FRAME SIZE (48)		MOTOR FRAME SIZE (56)		
	CAST IRON	BRONZE	CAST IRON	BRONZE	
1632, 34, 35			1604 - 023RP	1604 - 024RP	1600 - 050RP
1635	1600 - 175RP	1600 - 176RP	1604 - 025RP	1604 - 026RP	"
1616, 19, 36			"	"	1618 - 006RP
1619			1604 - 023RP	1604 - 024RP	"
1638, 40, 41			1604 - 025RP	1604 - 026RP	"

ITEM #25 REPLACEMENT IMPELLER ASSEMBLY							
PUMP NO.	(-9) PUMPS	CURRENT	DIA.	PUMP NO.	(-9) PUMPS	CURRENT	DIA.
121, 122	121 - 142BRP	SAME	4.300	1618	1618 - 001BRP	*N/A*	7.900
131,	131 - 075BRP	1630 - 023BRP	4.5	1619*	*N/A*	1619 - 001BRP	7.885
132,	132 - 063BRP	1630 - 022BRP	4.90	1620	1620 - 022BRP	*N/A*	5.100
133	133 - 075BRP	1632 - 022BRP	5.60	1622	1622 - 020BRP	*N/A*	5.800
138	138 - 037BRP	1634 - 023BRP	6.15	1624	1624 - 040BRP	*N/A*	6.500
1600	1600 - 079BRP	1610 - 020BRP	4.25	1630	1630 - 022BRP	SAME	4.900
1610	1610 - 019BRP	SAME	4.75	1632	1632 - 022BRP	SAME	5.600
1611*	*N/A*	1611 - 001BRP	4.73	1634	1634 - 023BRP	SAME	6.150
1612	1612 - 019BRP	SAME	5.50	1635*	*N/AS*	1635 - 001BRP	6.135
1614	1614 - 018BRP	SAME	6.10	1636	1636 - 001BRP	SAME	6.250
1615*	*N/A*	1615 - 001BRP	6.08	1638	1638 - 001BRP	SAME	7.000
1616	1616 - 002BRP	SAME	6.60	1640	1640 - 001BRP	*N/A*	7.900
				1641*	*N/A*	1641 - 001BRP	7.88

*When ordering, please advise diameter of impeller.

ITEM #31 REPLACEMENT MOTOR ASSEMBLY*				
HP	115/60/1	115/230/60/1	200/60/3	230/460/60/3
1/4	121 - 151RP	*N/A*	121 - 148RP	121 - 137RP
1/3	131 - 143RP	*N/A*	131 - 115RP	131 - 137RP
1/2	*N/A*	132 - 096RP	132 - 066RP	132 - 097RP
3/4	*N/A*	133 - 119RP	133 - 140RP	133 - 134RP
1	*N/A*	138 - 119RP	138 - 148RP	138 - 142RP
1½	*N/A*	1636 - 013RP	1636 - 019RP	1636 - 010RP
2	*N/A*	1638 - 012RP	1638 - 015RP	1638 - 010RP
3	*N/A*	*N/A*	1640 - 013RP	1640 - 010RP

*When ordering other than standard, refer to nameplate, then consult factory.

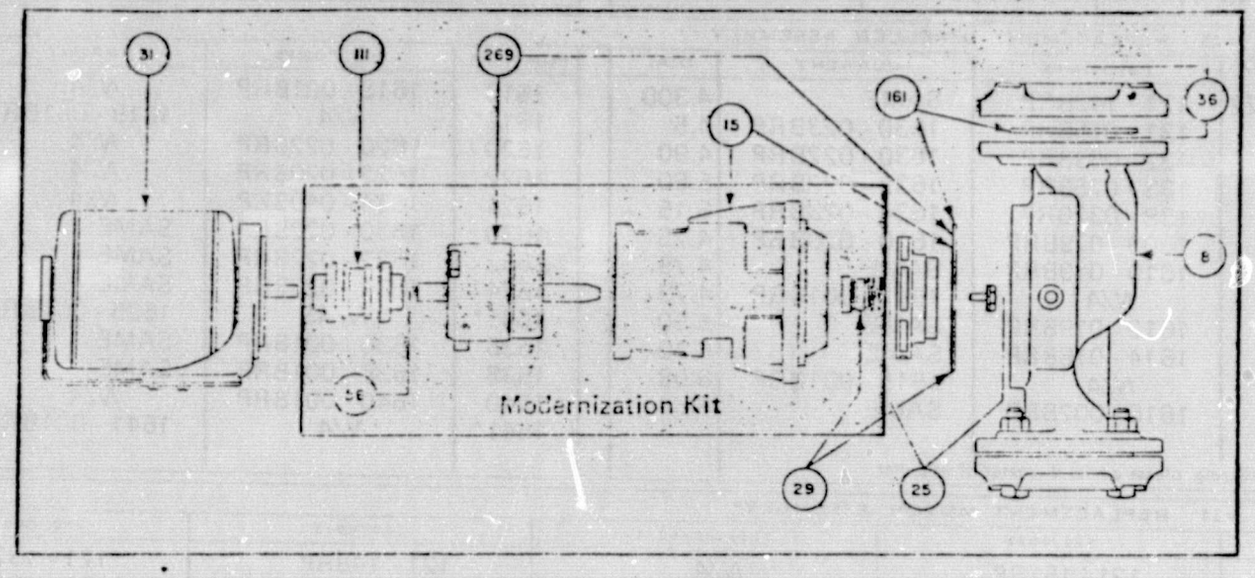
ITEM #34 SHAFT SLEEVE	1600 - 205RP	All –9 and Serial Number Pumps.
ITEM #56 COUPLER	1624 - 053RP	All Inline Pumps.
ITEM #111 RUBBER INSERT	1624 - 004RP	All Pumps with 1/4 thru 1 HP.
ITEM #111 RUBBER INSERT	1624 - 047RP	All Pumps with 1½ thru 3 HP.
ITEM #269 CARTRIDGE ASSY.	1600 - 160RP	All –9 and Serial Number Pumps.

Note (1) When replacing item #8 body on 131, 132, 133, 138 and 1600C - 1 & - 9, you must also order current style impeller.

Note (2) Body for the 1602 & 1604 are no longer available. Consult factory.

REPLACEMENT PARTS FOR OLD STYLE PUMPS AND CIRCULATORS

121 122, 131, 132, 138, 1600, 1602, 1604, 1610, 1612, 1614, 1620, 1622, 1624, 1630 1632 AND 1634



ITEM #8	BODY	Same as –9 and Serial Number Pumps.
ITEM #25	IMPELLER AND SHAFT ASSEMBLY	No longer available. Must purchase Item #74 Modernization Kit listed below.
ITEM #29	SEAL KIT	Part No. 1600-055RP
ITEM #31	MOTOR ASSEMBLY[1]	Same as –9 and Serial Number Pumps.
ITEM #36	FLANGE SET	Same as –9 and Serial Number Pumps.
ITEM #56	COUPLER	Same as –9 and Serial Number Pumps.
ITEM #111	RUBBER INSERT	Same as –9 and Serial Number Pumps.
ITEM #161	GASKET KIT	Same as –9 and Serial Number Pumps.

ITEM #74 MODERNIZATION KIT*

PUMP NO.	MOTOR FRAME SIZE (48)		MOTOR FRAME SIZE (56)	
	CAST IRON	BRONZE	CAST IRON	BRONZE
121, 122	121 - 154RP	122 - 002RP		
131, 132[2]	131 - 144RP	132 - 145RP	133 - 147RP	138 - 153RP
133, 138			"	"
1600, 1610	121 - 154RP	122 - 002RP		
1602, 1604[2]	131 - 144RP	132 - 145RP		
1612, 1620[2]	"	"	133 - 147RP	138 - 153RP
1630[2]	"	"	"	"
1614, 1622			"	"
1624, 1632			"	"
1634			"	"

Note (1) When replacing 1/3 or 1/2 HP 56 Frame (old) motor with a new 48 Frame motor, adapter kit #1600 - 194RP must be ordered.

Note (2) Select modernization kit per motor frame size. Select impellers per selection chart on previous page.

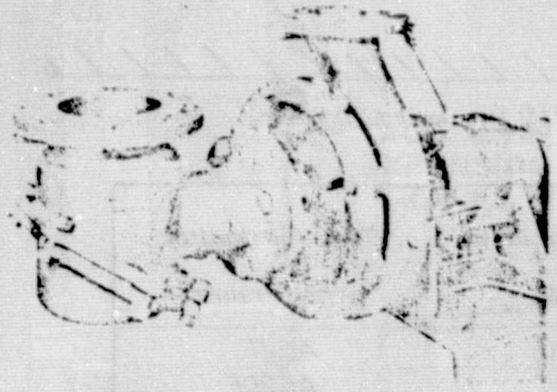
LABEL

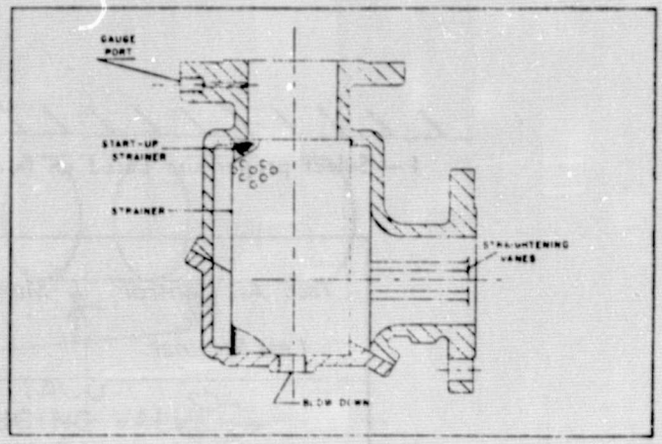
INSTRUCTION SHEET NUMBER

IS 400-5

TACO SUCTION DIFFUSER

EFFECTIVE: May 1, 1971
Supersedes: New





LOCATION & INSTALLATION

1. Locate and install pump per pump manufacturer's instructions.
2. Mount suction diffuser directly to pump suction flange. Pump and suction diffuser flanges should be aligned before connections are made. Piping should NEVER be drawn into place by force.
3. Both suction and discharge piping should be suspended or supported close to the pump so that no pipe weight rests on pump. To support the Suction Diffuser, cut a piece of 1¼" pipe without threads to the approximate length required from one of the bosses provided on the pump connection to the adjustable foot nut.
4. Place pipe on nut and under the boss and turn the nut counter-clockwise until sufficient load is supplied to give maximum support.

MOUNTING

1. Suction Diffusers can be mounted in a vertical or horizontal position. Bosses are cast for each position for pipe support.
2. If used in a horizontal position, the pump should be positioned at right angles to the piping. (See piping diagrams)

START-UP STRAINER REMOVAL

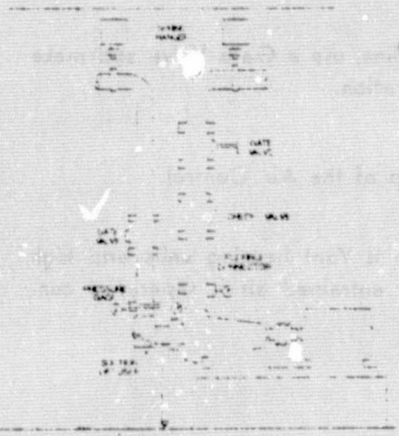
1. After 30 days of operation, remove and discard fine mesh start-up strainer and put back coarse mesh strainer.

2. To Remove Strainer:
   a. Close valves before and after suction diffuser.
   b. Remove plug in bottom of cover and drain.
   c. Unbolt strainer cover, then drop strainer and cover.
   d. Clean strainer and reverse above procedure.

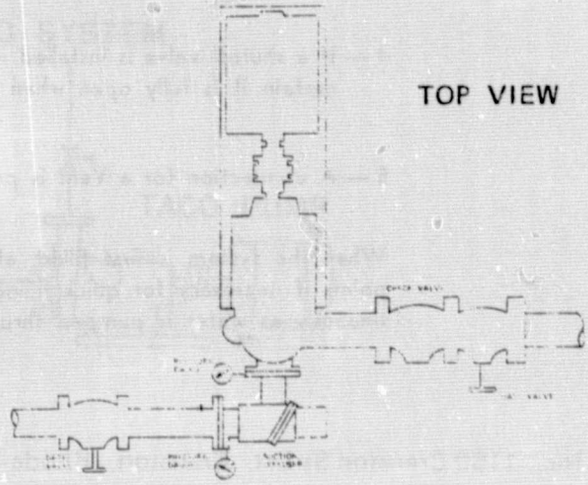
CLEANING

1. It is recommended that valved gauge connections be provided on diffuser inlet and pump suction connections to indicate when cleaning is needed.
2. Note pressure drop when strainer is clean; when the pressure drop increases 100%, remove the strainer and clean.

Vertical Installation Diagram



Horizontal Installation Diagram



Taco Heaters of Canada, Ltd.
3090 Lenworth Drive
Cooksville Ontario

TACO, INC. 1160 Cranston Street, Cranston, Rhode Island 02920 Printed in U.S.A.

TACO

INSTRUCTION SHEET

AIR CONTROL

NUMBER
IS-400-2-1

Effective: July 30, 1976
Supersedes: IS400-2-1 dated 3/15/66

1 — Select proper size based on flow (GPM) thru System

Taco Air Control Less Strainer	*Maximum Flow GPM*	*Taco Air Control With Strainer*
AC2	80	AC2F
AC25	130	AC25F
AC3	190	AC3F
AC4	330	AC4F
AC5	550	AC5F
AC6	900	AC6F
AC8	1500	AC8F
AC10	2600	AC10F
AC12	3400	AC12F
AC14	4700	AC14F
AC16	6000	AC16F
AC18	8000	AC18F
AC20	10000	AC20F

2 — Install Air Control in Supply Line between boiler and pump(s) as indicated in Diagram on reverse side.

3 — Install Expansion Tank (s) as close to Air Control as possible with horizontal pipe (if any) pitching up to tank.

4 — If a shutoff valve is installed in Expansion Tank line, use a Gate Valve and make certain it is fully open when system is in operation.

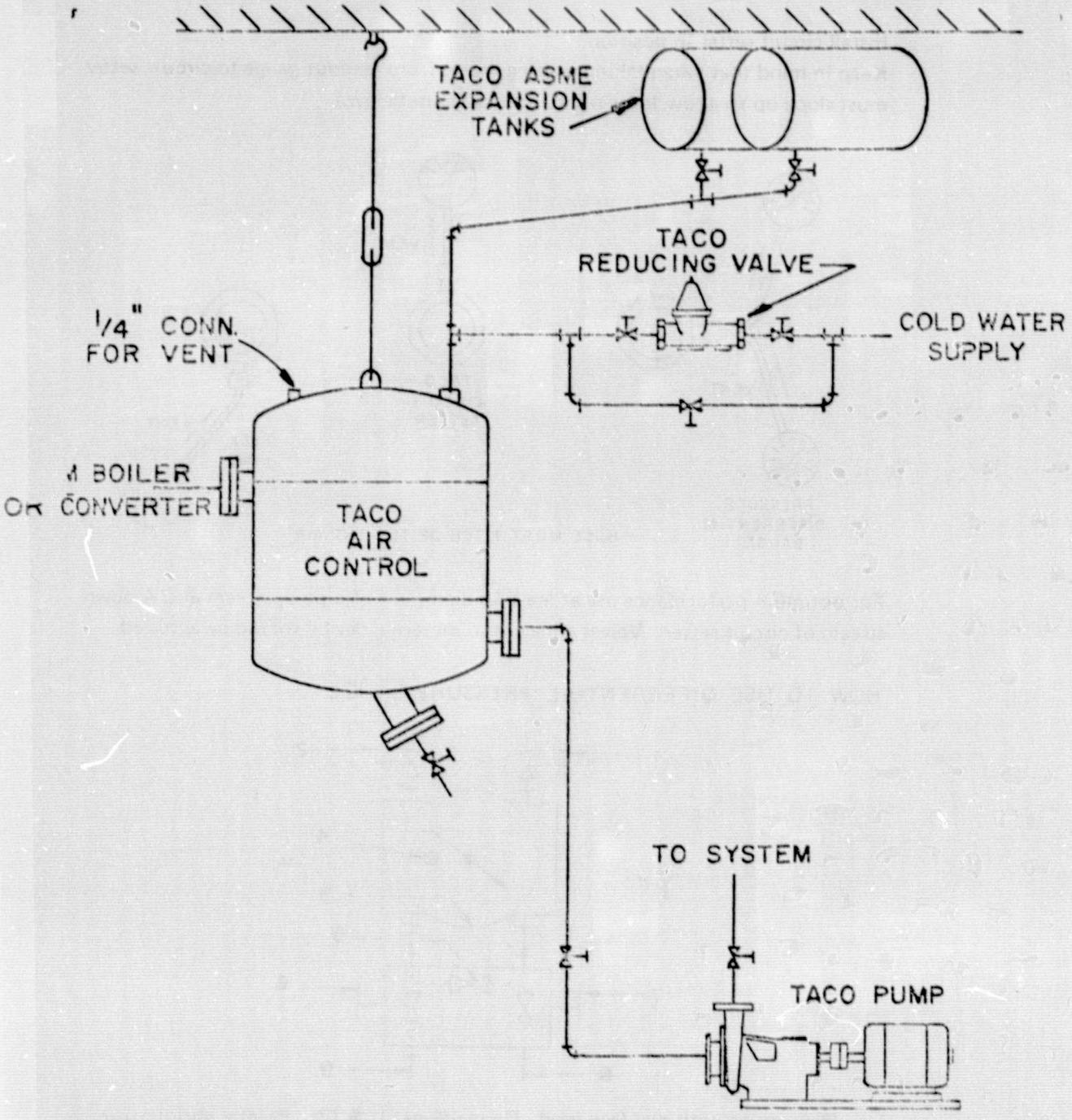
5 — A connection for a Vent is provided at the top of the Air Control.

When the system is first filled, all you have to do is Vent heating units and high points if necessary for quick filling. Thereafter, any entrained air is separated continuously as water is pumped thru the Air Control.

TACO, Inc. 1160 Cranston Street, Cranston, Rhode Island 02920 U.S.A. Telephone (401) 942-8000 Telex: 92-7627

TACO HEATERS OF CANADA, Ltd., 3090 Lenworth Drive, Mississauga, Ontario. Telephone: (416) 625-2160 Telex: (69)1179

AIR CONTROL


TACO ASME
EXPANSION
TANKS
TACO
REDUCING VALVE
1/4" CONN.
FOR VENT
COLD WATER
SUPPLY
BOILER
OR CONVERTER
TACO
AIR
CONTROL
TO SYSTEM
TACO PUMP

TACO

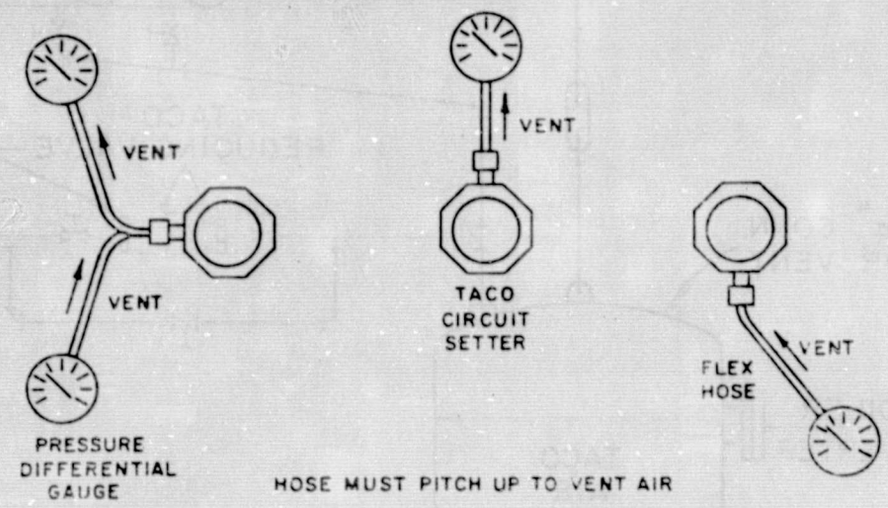
INSTRUCTION SHEET NUMBER

IS 400-4-4

TACO CIRCUIT SETTER

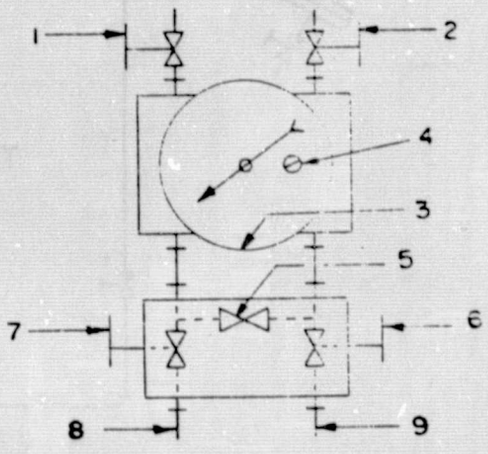
EFFECTIVE: May 15, 1972
Supersedes: NEW

Install circuit setter in position.
Keep in mind that when taking reading, hoses from readout gauge to circuit setter must slope up to allow for venting. (see diagram below.)



For optimum performance use at least 15 diameters of pipe upstream and 4 downstream of circuit setter. Valves adjacent to metering device should be avoided.

HOW TO USE DIFFERENTIAL PRESSURE GAUGE

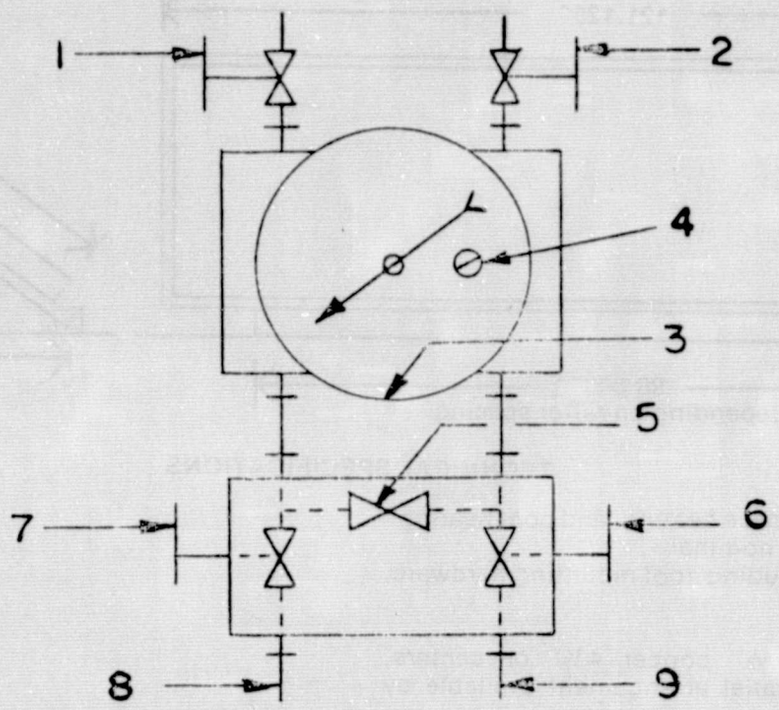


1. Place gauge with dial face level. Open valves (1) & (2). Pointer should read zero. If it does not, remove retainer (3) and glass. Turn screw (4) until pointer reads zero. Replace glass and retainer.

Taco Heaters of Canada, Ltd.
3090 Lenworth Drive
Cooksville, Ontario

TACO, INC. 1160 Cranston Street, Cranston, Rhode Island 02920

Printed in U.S.A.



2. Close valves (1) & (2). Open valve (5). Close valves (6) & (7)
3. Connect high pressure fitting (9) to upstream orifice tap and connect low pressure fitting (8) to downstream orifice tap of circuit setter using rubber hoses provided.
4. Open valves at orifice.
5. Open valves (6) & (7), and crack valves (1) & (2) until all air has been expelled from the gauge and hoses.
6. Close valves (1), (2), (6) and (7), keeping valve (5) open, pointer should then indicate zero. If it does not, air is trapped in the system. Repeat step 5 opening valves (6) & (7) alternately until all air is removed.
7. Open valves (6) & (7), close valve (5) and read pressure differential.
8. When through with test, open valve (5), close valves at orifice and remove hoses.
9. Open valves (1) & (2), and drain gauge and hoses.

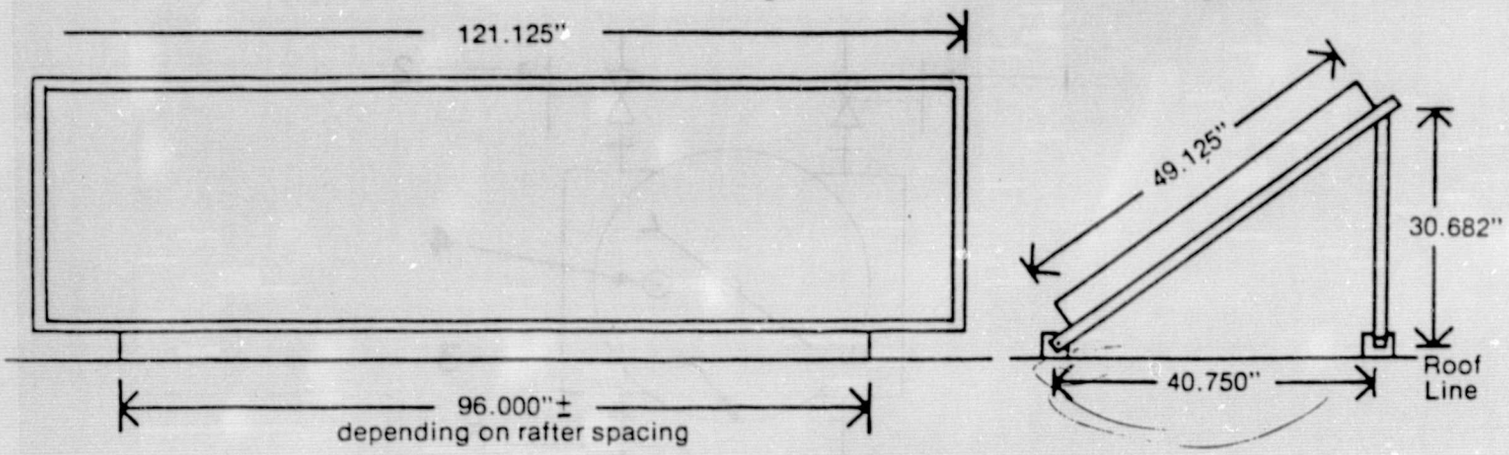
Once pressure differential readings are taken, refer to calculator to obtain flow corresponding to observed differential.

If flow is not in accordance with design flow rate, reset valve and repeat procedure explained above. This may have to be repeated several times throughout the system except when valves have been preset in accordance with engineer's specifications.

SDI Solar Collector

Shown for flat roof installation

Sloping roofs accommodated by adjusting rear strut length.



TECHNICAL SPECIFICATIONS

USES-water heating, space heating, and pool heating
DIMENSIONS - 4' x 10' nominal
WEIGHT - 140 lbs. including roof mounting hardware, 150 lbs. wet

PIPING - 100 ft. of ½" copper 4¾" on centers, sinusoidal layout, parallel arrangement available by special order
PIPE/PLATE CONNECTION - collector-plate grooved to accept ½ of pipe circumference for excellent heat transfer. 100% capillary flow solder bond.
BOX - extruded aluminum sides, .032" aluminum sheet backing
INSULATION - 2" technifoam isocyanurate

GLAZING - Kalwall Sun-lite Premium II
COLLECTOR PLATE - .012" thick copper, black chrome coated.
WIND LOADING - designed for 30 lbs./sq. ft.

The following data resulted in a value of 1.5 minutes for the SD6 collector's time constant.

TIME CONSTANT

DATE: August 18, 1978 WIND: SW at 1175 ft/min

Solar Time	°F T_i	°F T_o	$\frac{T_o - T_i}{T_{o,int} - T_i}$
14:34:30	101.62	118.50	1.000
- - - - - - - - - - Collector Covered - - - - - - - - - -			
14:35:00	101.62	116.62	0.889
14:35:30	101.61	111.79	0.603
14:36:00	101.63	107.47	0.346
14:36:30	101.61	104.82	0.190

Instantaneous Efficiency Performance Test

The instantaneous efficiency test with the collector at normal incidence was conducted at a constant flow rate while the inlet temperatures were varied for each set of efficiency points.

The data obtained and relevant calculated values are given in the attached tables. Following the tables are two graphs of the instantaneous efficiencies as a function of the inlet parameter, $(T_i - T_a/q_i)$, for each collector. Per client's request, the graphs were made in both English units (°F/BTU/ft^2/hr) and in metric units (°C/watt/m^2).

Analysis of the efficiency data was performed employing a 2nd order least squares polynomial which resulted in the following efficiency equations, which are shown as the analysis curves on the graphs.

Efficiency Equations (English) $[(T_i - T_a)/q_i]$ - (°F/BTU/ft^2/hr)

Model SD5 $\eta = 0.620 - 0.690 \left[\frac{T_i - T_a}{q_i}\right] - 0.030 \left[\frac{T_i - T_a}{q_i}\right]^2$

Model SD6 $\eta = 0.692 - 0.584 \left[\frac{T_i - T_a}{I_t}\right] - 0.500 \left[\frac{T_i - T_a}{I_t}\right]^2$

Efficiency Equations (Metric) $[(T_i-T_a)/q_i]$ -°C/watt/m^2)

Model SD5 $\eta = 0.620 - 3.950 \left[\frac{T_i-T_a}{I_t}\right] - 0.321 \left[\frac{T_i-T_a}{I_t}\right]^2$

Model SD6 $\eta = 0.692 - 3.322 \left[\frac{T_i-T_a}{I_t}\right] - 16.100 \left[\frac{T_i-T_a}{I_t}\right]^2$

At an inlet parameter of zero the equation for Model SD5 yields a value of 0.620 and the equation for Model SD6 yields a value of 0.692 for the effective transmittance-absorptance product, $F_R\alpha$, where F_R is the heat removal factor.

Differentiation of the English efficiency equations with respect to inlet parameter resulted in two expressions describing the overall heat losses, F_RU_L, from each collector. These expressions are given below along with their evaluation at a variety of inlet parameters.

Overall Heat Loss Expressions (English)

Model SD5 $\frac{d\eta}{d\left[\frac{T_i-T_a}{q_i}\right]} = F_RU_L = -0.690 - 0.060 \left[\frac{T_i-T_a}{q_i}\right]$

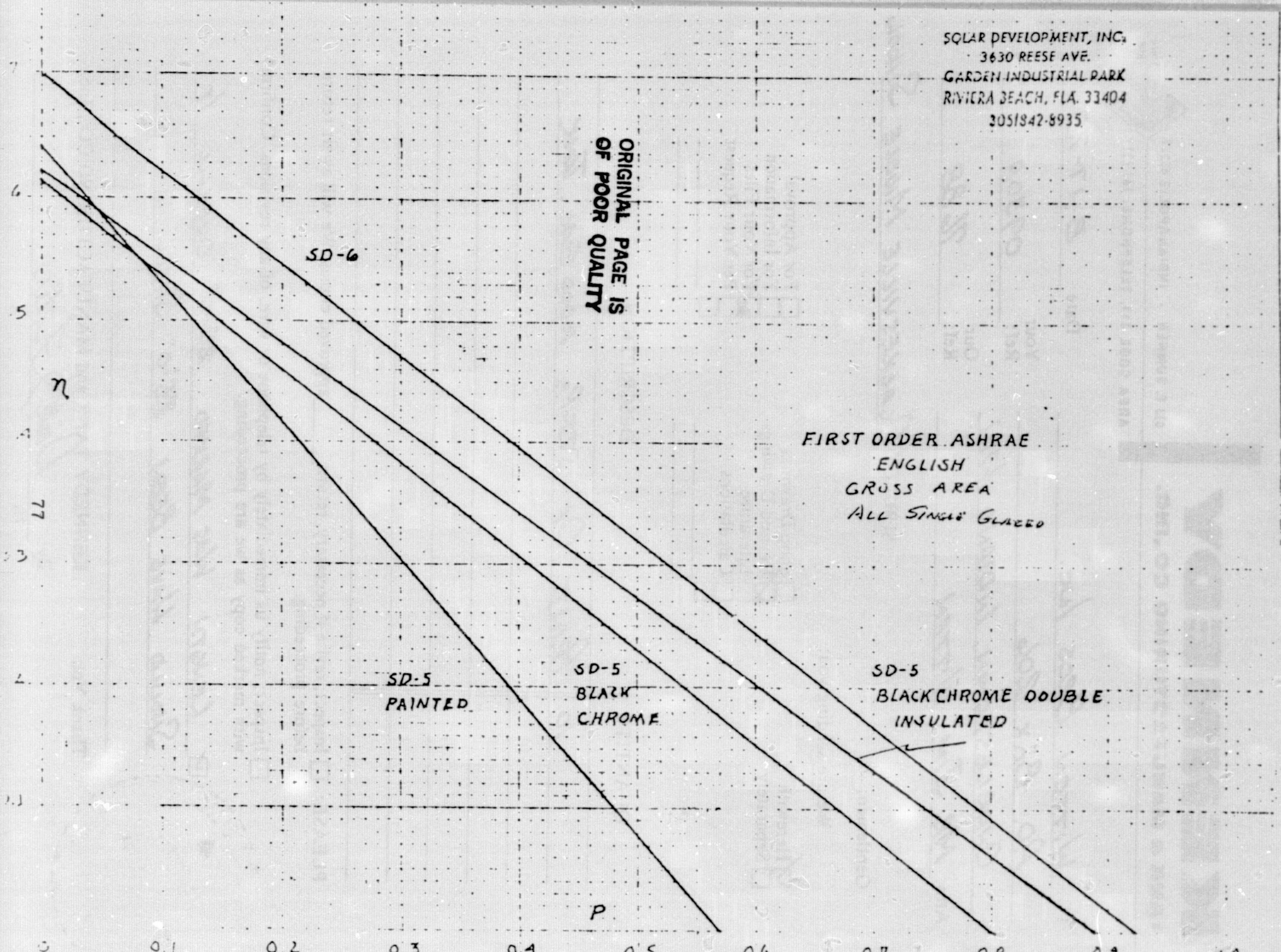
Model SD6 $\frac{d\eta}{d\left[\frac{T_i-T_a}{I_t}\right]} = F_RU_L = -0.584 - 1.000 \left[\frac{T_i-T_a}{I_t}\right]$

Inlet Parameter:*		0.05	0.25	0.45
Model SD5	F_RU_L:**	-0.693	-0.705	-0.717
Model SD6	F_RU_L:**	-0.634	-0.834	-1.034

*°F/BTU/ft^2.hr

**BTU/ft^2.hr/°F, negative sign denotes loss

SOLAR DEVELOPMENT, INC.
3630 REESE AVE.
GARDEN INDUSTRIAL PARK
RIVIERA BEACH, FLA. 33404
305/842-8935



FIRST ORDER ASHRAE
ENGLISH
GROSS AREA
ALL SINGLE GLAZED

KENNEDY
TANK & MANUFACTURING CO., INC.

833 E. SUMNER · INDIANAPOLIS 46227
AREA CODE 317, TELEPHONE: 787-1311

Since 1898

TO: WITTEN BROS. INC.
P.O. BOX 206
CHARLESTOWN, INDIANA 47111
Attn: MR. JIM WITTEN

Date 8-17-78
Your Ref: 0930A
Our Ref: 7688

SUBJECT CLARKESVILLE MIDDLE SCHOOL

Gentlemen:

We are sending you:

- [x] Herewith
- [ ] Separately

- [ ] Shop Drawings
- [x] Revised Drawings
- [ ] Literature
- [ ] Calculations
- [ ] _____

- [ ] For Approval
- [ ] For Information
- [x] For Your Files
- [ ] Per Your Request
- [ ] _____

QUANTITY	DESCRIPTION
10	PRINTS OF STT-P3 10,000 GAL. TANK

PLEASE:

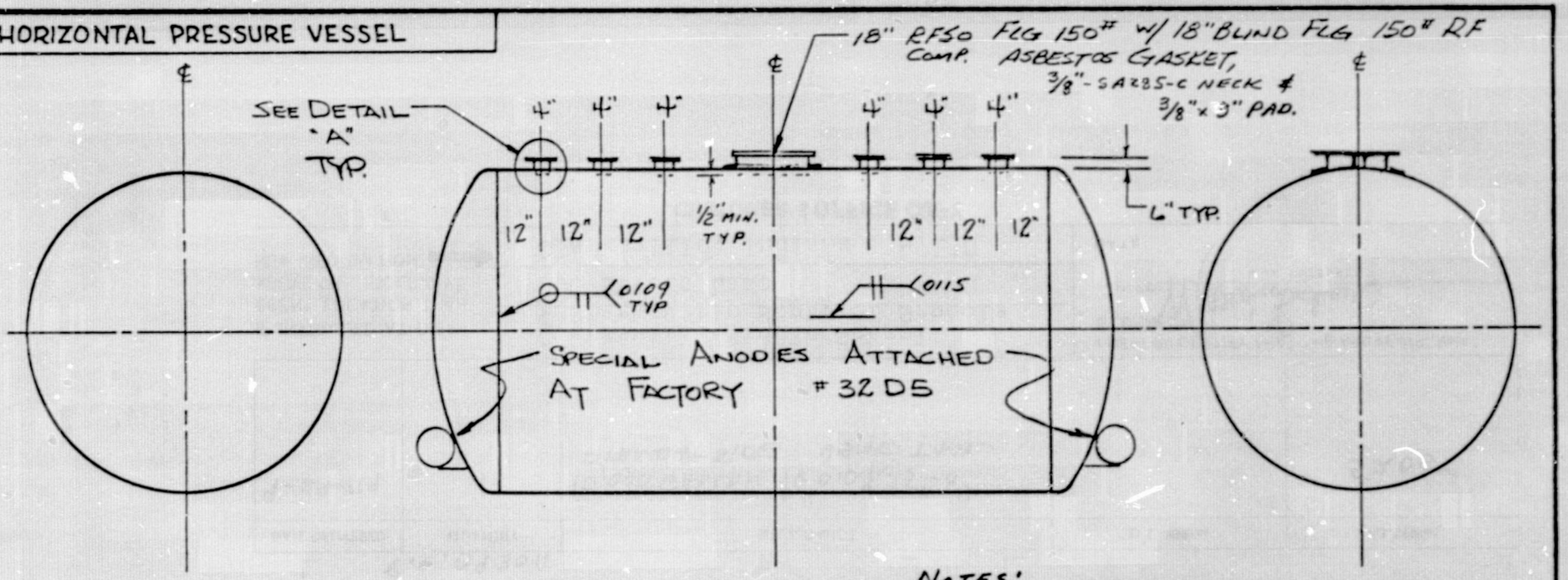
- [ ] Inspect; revise if necessary, return _____ approved copies. We will await return before proceeding.
- [ ] Inspect; notify us immediately by telephone or wire, of any revisions. Confirm with marked copy as we are proceeding.
- [x] LENGTH WAS MARKED 25'-0" OVERALL IT SHOULD HAVE BEEN 25'-0" SHELL.

Thank You.

KENNEDY TANK and MANUFACTURING CO., Inc.

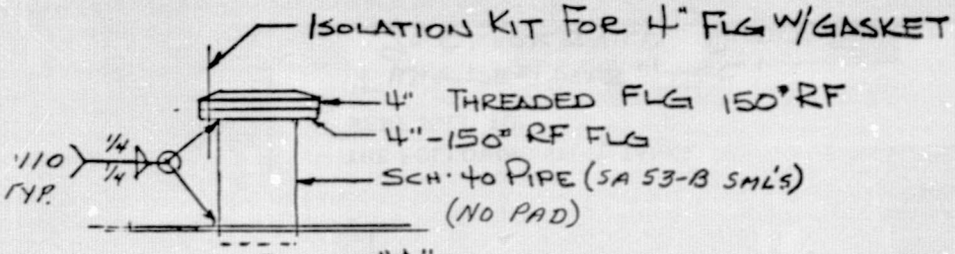
By: Dick Foster

HORIZONTAL PRESSURE VESSEL



NOTES:

1. BOLT HOLES TO STRADDLE ℄.



DETAIL "A"

TANK WT. 9050#

STI-P3 S/N 5205

FOR WITTEN BROS. INC. c/o CLARKSVILLE MIDDLE SCHOOL CLARKSVILLE, IND.		HEADS ASME F&D 96"OD 3/8" NOM. 90"RD, 5 1/8" ICR, 2"SF SA 516-70			SHELL 1/4" SA 285C
		WORKING PRESSURE 50 PSIG	TEST PRESSURE 75 PSIG	A.S.M.E. LABEL YES	
QUANTITY REQUIRED ONE (1)	CAPACITY 19000 GAL.	PAINT PER STI-P3	DRAWN BY DF	DATE 5-22-78	CHECKED BY [illegible]
DESCRIPTION UNDERGROUND STORAGE		KENNEDY TANK & MANUFACTURING CO., INC. 833 EAST SUMNER AVENUE INDIANAPOLIS, INDIANA 46227			
DIAMETER 96"	LENGTH 25'-0" SHELL ~~OVERALL~~	CUSTOMER'S ORDER NO. 0930A		OUR ORDER NO. 7688	

DWG. NO. 13981-A.

STEEL TANK INSTITUTE
111 EAST WACKER DRIVE
CHICAGO, ILL. 60601

STI - P_3
20 YEAR WARRANTY

THE FOLLOWING STI-P_3 TANKS WERE SOLD TO:

WITTEN BROS, INC,
90 CLARKSVILLE MIDDLE SCHOOL
CLARKSVILLE, IND,
P.O. 0930A

THESE TANKS WERE MANUFACTURED TO STI-P_3 SPECIFICATIONS BY:

KENNEDY TANK & MFG. CO., INC.
833 E. SUMNER AVE.
INDIANAPOLIS, INDIANA 46227

DATE DELIVERED	QUANTITY	SIZE & GAUGE	U. L. SERIAL	P-3 SERIAL
9-29-79	1	10,000 GALLON 96" O.D. X 25'-0" STRAIGHT SIDE ASME TANK		5205

IF INSTALLED AT DIFFERENT LOCATION THAN ABOVE OR RESOLD GIVE NEW INFORMATION. →

Clarksville Middle School
% Clarksville Supt. of Schools
200 Ettels Lane
Clarksville, Indiana 47130

I HEREBY CERTIFY THAT THE ABOVE INFORMATION IS CORRECT.

SIGNED Marvin Kochmer
MANUFACTURER

DATE

CUSTOMER'S OFFICE COPY

FORM U-1A MANUFACTURERS' DATA REPORT FOR PRESSURE VESSELS

(Alternate Form for Single Chamber, Completely Shop-Fabricated Vessels Only)
As Required by the Provisions of the ASME Code Rules, Section VIII, Division 1

1. Manufactured by Kennedy Tank & Mfg. Co., Inc., 833 E. Sumner Ave., Indianapolis, IN 46227
2. Manufactured for Witten Bros., Inc., P. O. Box 206, Charlestown, IN 47111
3. Location of Installation Clarksville Middle School, Clarksville, Indiana
4. Type Horiz. Tank (Horiz. or vert. tank) 3724 (Mfgr's Serial No.) (CRN) 13981-A (Drawing No.) 3724 (Nat'l Brd No.) (Year Built) 1978
5. The chemical and physical properties of all parts meet the requirements of material specifications of the ASME BOILER AND PRESSURE VESSEL CODE. The design, construction, and workmanship conform to ASME Rules, Section VIII, Division 1 1977 (Year) and Addenda to W-77 (Date) and Code Case Nos. --
Special Service per UG-120(d) --
Manufacturers' Partial Data Reports properly identified and signed by Commissioned Inspectors have been furnished for the following items of the report: --
6. Shell: Matl. SA285-C (Spec. No., Grade) Nom. Thk. 1/4 Corr. in. Allow. 0 in. Diam. 96 in. Lgth. 23 ft 7 1/2 in.
7. Seams: Long. Dbl. butt (Welded, Dbl, Sngl, Lap, Butt) R.T. None (Spot or Full) Efficiency 70 % H.T. Temp. -- F Time -- hr
Girth Crimp UW-13.1 (K) (Welded, Dbl, Sngl, Lap, Butt) R.T. None (Spot, Partial, or Full) No. of Courses 4
8. Heads: (a) Material SA515-70 (Spec. No., Grade) (b) Material SA515-70 (Spec. No., Grade)

	Location (Top, Bottom, Ends)	Min. Thk.	Corr. Allow.	Crown Radius	Knuckle Radius	Ellipse Ratio	Conical Apex Angle	Hemisph. Radius	Flat Diam.	Side to Pressure (Convex or Concave)
(a)	Ends	1/4"	0			2:1				Concave
(b)										

If removable, bolts used (describe other fastenings) (Material, Spec. No., Gr., Size, No.)
9. Constructed for max. allowable working pressure 50 psi at max. temp. 650° F. Min. temp. (when less than -20 F) F. Hydrostatic, ~~pneumatic or combination~~ test pressure 75 psi.
10. Safety Valve Outlets: Number Size Location in line by customer
11. Nozzles and Inspection Openings:

Purpose (Inlet, Outlet, Drain)	No.	Diam. or Size	Type	Matl.	Nom. Thk.	Reinforcement Matl.	How Attached	Location
	6	4"	Pipe	SA53-B	Sch. 40	Inherent	Arc weld	
Manhead	1	18"	Plate Ring	SA285-C	3/8"	SA285-C	Arc weld	Shell

12. Supports: Skirt No (Yes or no) Lugs -- (No.) Legs -- (No.) Other -- (Describe) Attached -- (Where and how)
13. Remarks: underground storage tank.
Customer's Purchase Order No. 0930A

CERTIFICATE OF COMPLIANCE

We certify that the statements made in this report are correct and that all details of design, material, construction, and workmanship of this vessel conform to the ASME Code for Pressure Vessels, Section VIII, Division 1.
Date 12-11-78 Signed Kennedy Tank & Mfg. Co., Inc. (Manufacturer) by Warren E. Morgan (Representative)
"U" Certificate of Authorization No. 131 expires March 30, 1980

CERTIFICATE OF SHOP INSPECTION

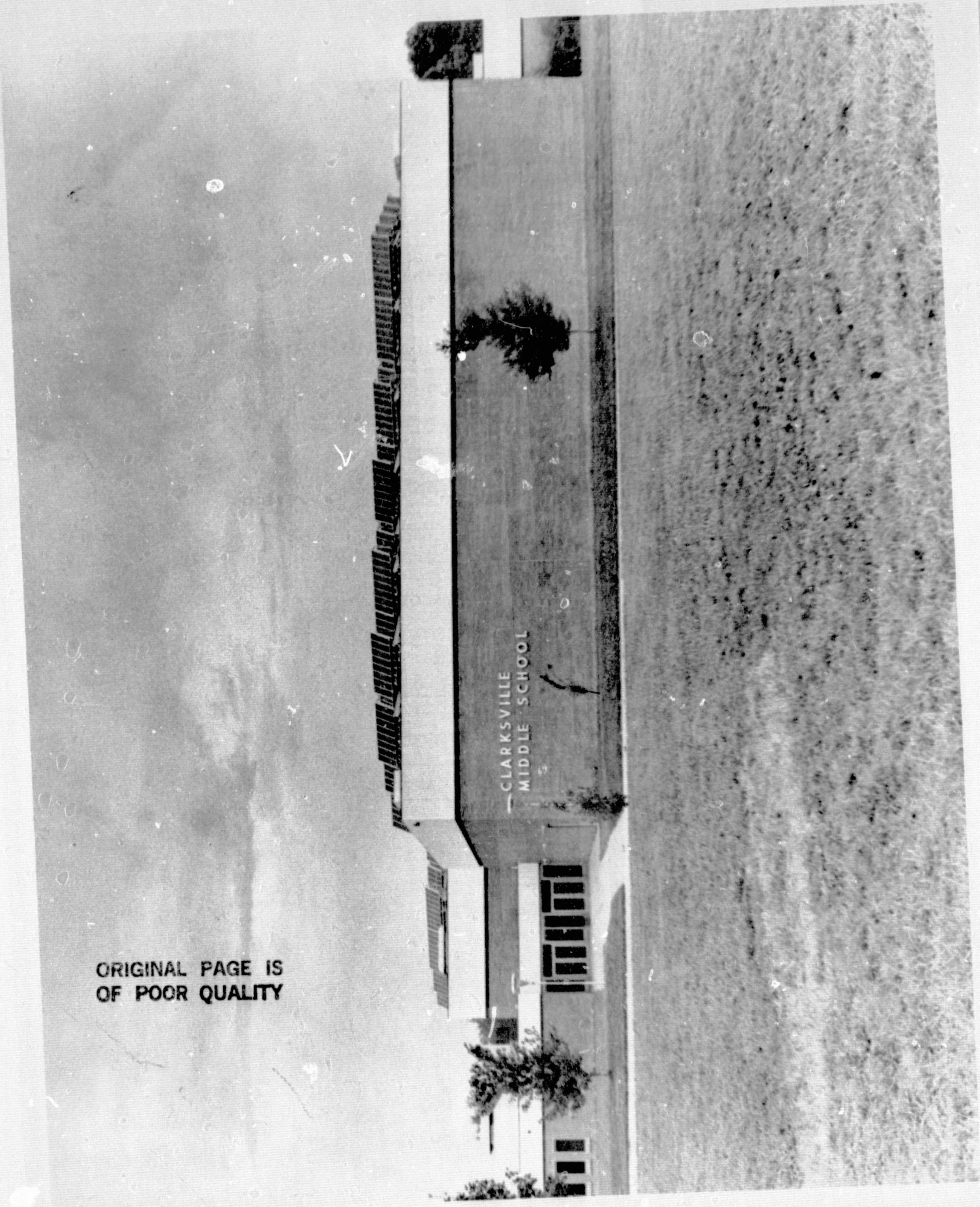
Vessel made by Kennedy Tank & Mfg. Co., Inc. at Indianapolis, Indiana
I, the undersigned, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and/or the State or Province of Indiana and employed by H.S.B. I & I Co. have inspected the pressure vessel described in this Manufacturers' Data Report on September 26, 1978, and state that, to the best of my knowledge and belief, the Manufacturer has constructed this pressure vessel in accordance with ASME Code, Section VIII, Division 1. By signing this certificate neither the Inspector nor his employer makes any warranty, expressed or implied, concerning the pressure vessel described in the Manufacturers' Data Report. Furthermore, neither the Inspector nor his employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection.
Signed William E. Braden (Inspector) Date 2/2/79 Commissions N.B. 7448 (Nat'l Board, State, Province and No.)

APPENDIX C

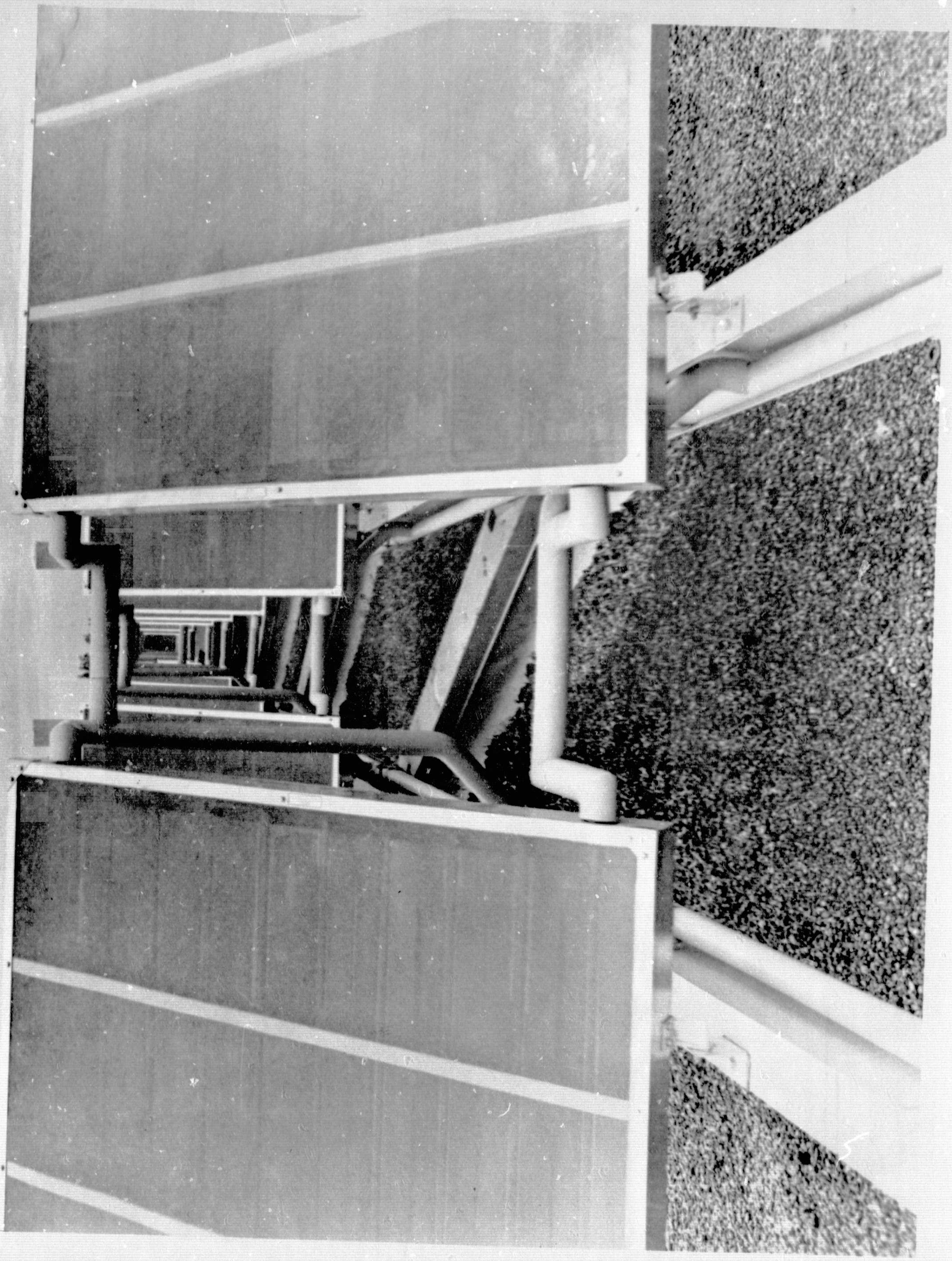
INSTALLATION PICTURES

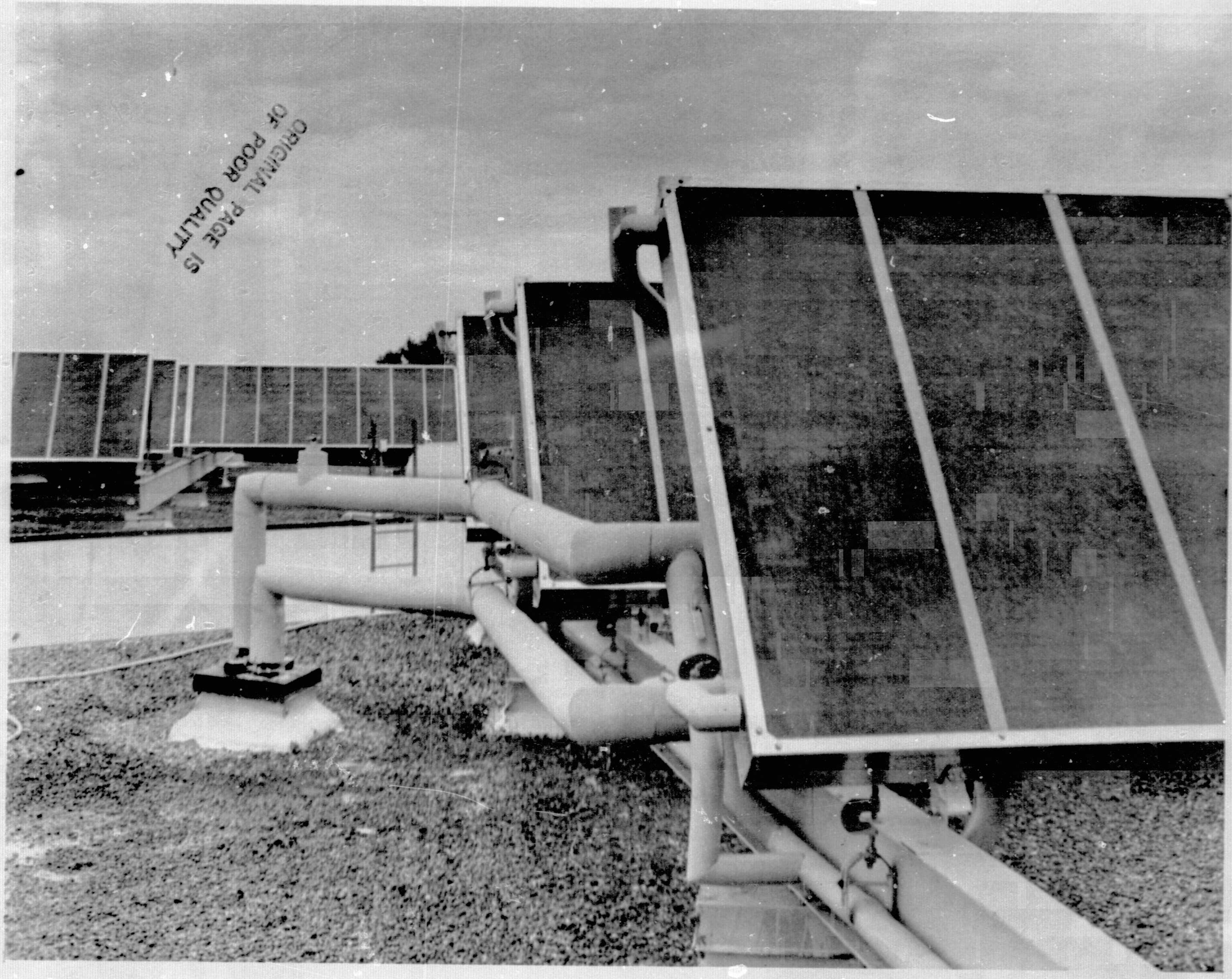
CLARKSVILLE MIDDLE SCHOOL

TABLE OF CONTENTS




CLARKSVILLE
MIDDLE SCHOOL





APPENDIX D

SYSTEM PERFORMANCE DATA

System and Subsystem Performance/Technical Data*

A. *Climatalogical Data:*

For the proposed project site provide the following information:

1. Latitude 38°

2. Heating degree days - Louisville, Kentucky

   Yearly 4660

   January 930

3. Annual Cooling Hours N/A

4. Peak daily insolation 2284 BTU/ft² @ 40° Latitude, 50° collector angle south facing surface, March 21.

5. Yearly sunshine 57% %

B. *Collector:* Commercial/Brand Name Solar Development, Inc. Model SD-5

1. Type of Collector

   a. Flate Plate 1/2" type M copper tube bonded to 0.012" formed copper plate.

   b. Tubular N/A

      i) Acceptance Angle _____

      ii) Concentration _____

      iii) Interception Area _____

      iv) Mirror Reflector Characteristics _____

   c. Concentrator N/A

      i) Focusing _____

      ii) Non-Focusing _____

      iii) Tracking _____; Mode _____

      iv) Non-Tracking _____

      v) Concentration Ratio _____

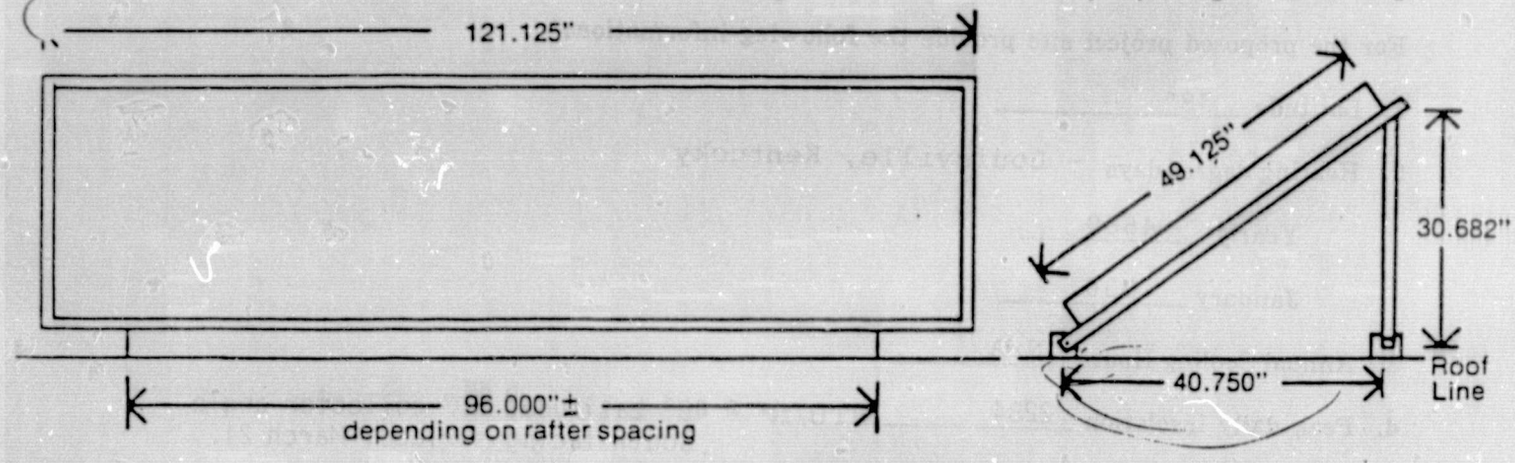
      vi) Reflector Reflection _____

* All data requested in this Appendix must be supplied or a statement given as to why it was omitted. Data requested are specified for single system or subsystem. If more than one, specify and supply data for each.

SDI Solar Collector

Shown for flat roof installation

Sloping roofs accommodated by adjusting rear strut length.



TECHNICAL SPECIFICATIONS

USES-water heating, space heating, and pool heating
DIMENSIONS - 4' x 10' nominal
WEIGHT - 140 lbs. including roof mounting hardware, 150 lbs. wet

PIPING - 100 ft. of ½" copper 4¾" on centers, sinusoidal layout, parallel arrangement available by special order
PIPE/PLATE CONNECTION - collector-plate grooved to accept ½ of pipe circumference for excellent heat transfer. 100% capillary flow solder bond.
BOX - extruded aluminum sides, .032" aluminum sheet backing
INSULATION - 2" technifoam isocyanurate

GLAZING - Kalwall Sun-lite Premium II
COLLECTOR PLATE - .012" thick copper, black chrome coated.
WIND LOADING - designed for 30 lbs./sq. ft.

System and Subsystem Performance/Technical Data--Continued

2. Transparent Cover

   a. Materials

      1. Type Kalwall Sunlite Premium II Single Glazed, 0.04"

      2. Composition Polyester Acrylic and Glass Fibre

   b. Commercial Identification Kalwall

   c. Solar Spectrum Transmissivity ASTM E424 0.25-0.90 %

   d. Solar Spectrum Reflectivity See Attached Kalwall Data %

   e. Infrared Transmissivity _____ %

   f. Infrared Reflectivity _____ %

   g. Number of Covers _____ %

   h. Combustibility _____

   i. Edge Treatment _____

   j. Physical Properties**

      1. Density _____

      2. Linear Coefficient of Expansion _____

      3. Thermal Conductivity _____

      4. Specific Heat _____

      5. Tensile Strength _____

      6. Compressive Strength _____

      7. Weight _____

3. Absorber Plate

   a. Absorptive Coating

      1. Materials

         a. Type Black Chrome

*

** Properties of conventional materials that are available in standard references such as Mark's Engineering Handbook need not be restated here provided the material is adequately specified so that its properties can be determined from such references. Properties of materials not commonly available in standard references should be submitted with system data to the extent known.

SUN-LITE PREMIUM II

* Solar Energy Transmission - 88% at 0° and 73% at 60° (incidence angle).
* Moist Heat Resistance - 3% transmission loss after a seven day steam test.
* Ultraviolet Degradation - 2% transmission loss after 1,000 hour fadeometer exposure.
* Thermal Degradation - 300 hours at 150°F, 200°F, and 300°F cause a 1%, 3%, and 11% transmission loss respectively.
* Combustibility Characteristics - 100 flamespread, 250 smoke, by ASTM-E-84 Tunnel Test. Ignition temperature, 950°F.
* Impact Resistance - 50 ft. lbs. (.040" thickness)
* Thermal Shock - no harmful effects.

Additional Properties:

Tensile Strength, psi	11,286
Tensile MOE, psi x 10^6	0.98
Tensile Elongation, %	1.4
Flexural Strength, psi	17,018
Flexural MOE, psi x 10^6	0.81
Compressive Strength, psi	14,396
Specific Gravity	1.352

(The above information is presented in good faith and believed to be correct to the best of our knowledge, but no warranty is expressed or implied.)

NEW!

SUN-LITE PREMIUM II

Properties!

- high impact resistance
- shatterproof
- easily cut and installed
- lightweight
- flexible
- solar properties equal to or better than glass
- economical
- inert to chemical atmospheres
- easily maintained

SUN-LITE IS A NEW CLASS OF GLASS FIBER REINFORCED POLYMER DEVELOPED SPECIFICALLY FOR SOLAR COLLECTOR GLAZING

SOLAR COMPONENTS DIVISION
Kalwall Corporation
88 Pine Street
Manchester, N. H. 03103
Phone 603 — 668-8186

System and Subsystem Performance/Technical Data–Continued

b. Alloy _____

c. Commercial Identification _____

2. Solar Spectrum Absorptivity Unknown %

3. Infrared Emissivity Unknown %

b. Base Plate

1. Materials

a. Type Copper Plate

b. Alloy Copper Producer 110

c. Commercial Identification _____

2. Thermal Properties

a. Thermal Conductivity See Mark's Handbook

b. Specific Heat _____

3. Physical Properties

a. Linear Coefficient of expansion _____

b. Density _____

c. Tensile Strength _____

d. Compressive Strength _____

4. Bonding Materials

a. Type (Brazed, Soldered, etc.) 50/50 Solder Plate to Tube
95/5 Solder Pressure Boundaries

b. Composition _____

c. Commerical Identification _____

4. Insulation

a. Materials

1. Type Foam

2. Composition Isocyanurate

3. Commercial Identification Technifoam-Celotex

C-2

System and Subsystem Performance/Technical Data–Continued

b. Outgassing Characteristics

1. Outgassing Temperature 250°F
2. Gas given off
3. Any Condensation No

c. Physical Properties

1. Linear Coefficient of expansion $5X10^{-5}$ in/in - F°
2. Density 1.8-2.3 LBS/FT^3
3. Thermal Conductivity 0.1 BTU/FT^2 - HR - F°/in @ 75°F
4. Specific Heat
5. Coefficient of Cubical expansion $5x10^{-5}$ in/in-F°
6. Dimensions 2in.x10FT x 4FT.

5. Outer Base Enclosure

a. Materials

1. Type Extruded Aluminum
2. Composition 6063-T5
3. Commercial Identification
4. Combustibility

b. Physical Properties (As Applicable)

1. Linear Coefficient of expansion See Mark's Handbook
2. Density
3. Thermal Conductivity
4. Specific Heat
5. Coefficient of Cubical expansion
6. Dimensions

c. Thermal Conductivity

System and Subsystem Performance/Technical Data–Continued

6. Composite Collector

a. Cooling/Transport Fluid

1. Fluid

a. Commercial Identification _____

b. Type Water

2. Additives

* a. Commercial Identification Prestone II - Union Carbide

b. Type Ethylene Glycol

3. Quantities of fluid in collector 1.24

* a. Fluid 50% %

* b. Additive 50% %

4. pH _____

5. Ion Content See Ashrae Handbook

6. Mineral Content 1972 Flundamentals pp. 280-282

7. Durability (Service Life) _____ mos.

8. Properties

a. Thermal Conductivity _____

b. Specific Heat _____

c. Density _____

d. Viscosity _____

e. Coefficient of Cubical expansion _____

9. Other pertinent qualities _____

b. Performance Data—Provide test or Performance Analysis Data along with information detailing the conditions under which the data were generated. Active systems require that test results be submitted rating the solar collector in accordance with the NBS "Method of Testing for Rating Solar Collectors Based on Thermal Performance," Document NBSIR 74-365,* or through other procedures which will provide similar performance information, as determined by ERDA.

* Request for copies of this document should be addressed to Energy Research & Development Administration (ERDA), Technical Information Center, P.O. Box 62, Oak Ridge, Tennessee 37830.

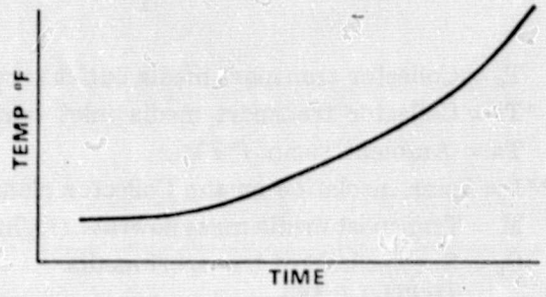
System and Subsystem Performance/Technical Data–Continued

Passive systems require that sufficient calculations or test results to determine how effective the concepts will be in providing the neccessary functions. As a minimum, the following should be provided.

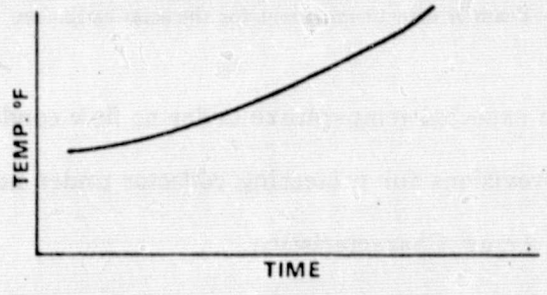
1. Test method used ASHRAE Florida Solar Energy Center
2. Energy Collection Rate (BTU/Hr-ft²) Versus time for selected winter conditions and (if applicable) for selected summer conditions over a collection day. The following should be provided:

See Test Data Attached

   a. Collector Orientation
      1. Azimuth _____ Degrees
      2. Elevation _____ Degrees
   b. Ambient Conditions
      1. Temperature _____ °F
      2. Wind Velocity _____ MPH
      3. Wind Direction _____ Degree
   c. Insolation
   d. Collection Period (Time of Day) _____ to _____.
      1. Provide Graph of Inlet Temperatures



      2. Provide Graph of Outlet Temperatures



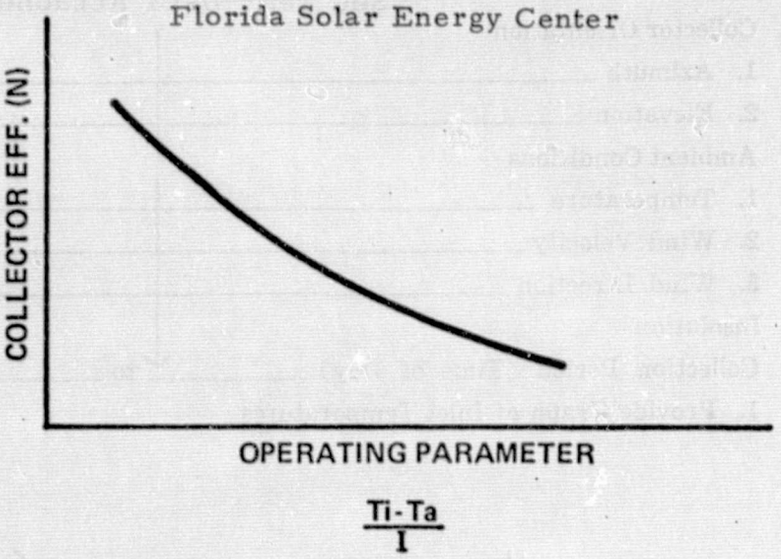
System and Subsystem Performance/Technical Data–Continued

3. Provide a graph of Collector efficiency (n) versus the parameter $\frac{Ti - Ta.}{I}$

where $n = \frac{MC_p (T_o - T_i)}{A_c I}$

* See Attached Graph by

Florida Solar Energy Center



T_o = Collector transport media outlet temperature (°F)

*Ti = Collector transport media inlet temperature (°F)

Ta = Ambient Temp. (°F)

**I = Solar Insolation on the Collector plane (BTU/HR – FT^2)

M = Transport media mass flowrate (lb/hr)

C_p = Specific heat of transport media (BTU/LB °F)

A_c = Area of Collector (ft^2)

*Average Collector Temp. may be used $\frac{T_i + T_o}{2}$

**For concentrating collectors this value should be only the beam or direct component for the solar radiation.

* 4. Maximum expected temperature under no flow conditions 278°F

5. Discuss provisions for protecting collector under no flow conditions. Relief Value

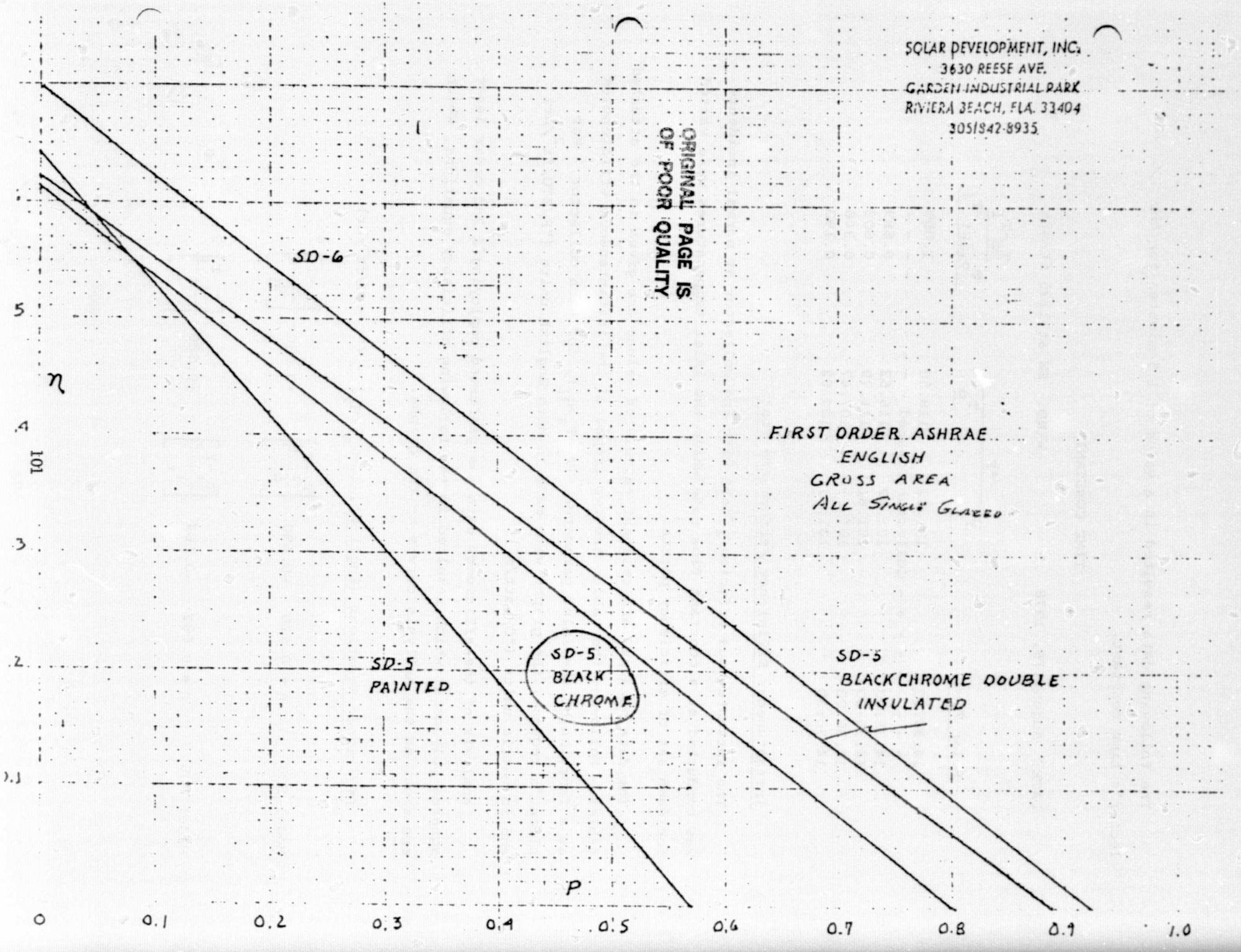
6. Collector Array Characteristics

a. Total Area 41.3 ft^2

b. Solar Window Area 40 ft^2

c. Weights of Collector and Framing 3.5 lbs/ft^2

SOLAR DEVELOPMENT, INC.
3630 REESE AVE.
GARDEN INDUSTRIAL PARK
RIVIERA BEACH, FLA. 33404
305/842-8935



The following data resulted in a value of 1.5 minutes for the SD6 collector's time constant.

TIME CONSTANT

DATE: August 18, 1978 WIND: SW at 1175 ft/min

Solar Time	°F T_i	°F T_o	$\frac{T_o - T_i}{T_{o,int} - T_i}$
14:34:30	101.62	118.50	1.000
- - - - - - - - - -	Collector Covered	- - - - - - - - - -	- - -
14:35:00	101.62	116.62	0.889
14:35:30	101.61	111.79	0.603
14:36:00	101.63	107.47	0.346
14:36:30	101.61	104.82	0.190

Instantaneous Efficiency Performance Test

The instantaneous efficiency test with the collector at normal incidence was conducted at a constant flow rate while the inlet temperatures were varied for each set of efficiency points.

The data obtained and relevant calculated values are given in the attached tables. Following the tables are two graphs of the instantaneous efficiencies as a function of the inlet parameter, $(T_i - T_a/q_i)$, for each collector. Per client's request, the graphs were made in both English units (°F/BTU/ft^2/hr) and in metric units (°C/watt/m^2).

Analysis of the efficiency data was performed employing a 2nd order least squares polynomial which resulted in the following efficiency equations, which are shown as the analysis curves on the graphs.

Efficiency Equations (English) $[(T_i - T_a)/q_i]$ - (°F/BTU/ft^2/hr)

Model SD5 $\eta = 0.620 - 0.690 \left[\frac{T_i - T_a}{q_i}\right] - 0.030 \left[\frac{T_i - T_a}{q_i}\right]^2$

Model SD6 $\eta = 0.692 - 0.584 \left[\frac{T_i - T_a}{I_t}\right] - 0.500 \left[\frac{T_i - T_a}{I_t}\right]^2$

Efficiency Equations (Metric) $[(T_i-T_a)/q_i]$ -°C/watt/m^2)

Model SD5 $\eta = 0.620 - 3.950 \left[\frac{T_i-T_a}{I_t}\right] - 0.321 \left[\frac{T_i-T_a}{I_t}\right]^2$

Model SD6 $\eta = 0.692 - 3.322 \left[\frac{T_i-T_a}{I_t}\right] - 16.100 \left[\frac{T_i-T_a}{I_t}\right]^2$

At an inlet parameter of zero the equation for Model SD5 yields a value of 0.620 and the equation for Model SD6 yields a value of 0.692 for the effective transmittance-absorptance product, $F_R(\alpha\tau)$, where F_R is the heat removal factor.

Differentiation of the English efficiency equations with respect to inlet parameter resulted in two expressions describing the overall heat losses, F_RU_L, from each collector. These expressions are given below along with their evaluation at a variety of inlet parameters.

Overall Heat Loss Expressions (English)

Model SD5 $\frac{d\eta}{d\left[\frac{T_i-T_a}{q_i}\right]} = F_RU_L = -0.690 - 0.060 \left[\frac{T_i-T_a}{q_i}\right]$

Model SD6 $\frac{d\eta}{d\left[\frac{T_i-T_a}{I_t}\right]} = F_RU_L = -0.584 - 1.000 \left[\frac{T_i-T_a}{I_t}\right]$

Inlet Parameter:*		0.05	0.25	0.45
Model SD5	F_RU_L:**	-0.693	-0.705	-0.717
Model SD6	F_RU_L:**	-0.634	-0.834	-1.034

*°F/BTU/ft^2.hr

**BTU/ft^2.hr/°F, negative sign denotes loss

System and Subsystem Performance/Technical Data–Continued

C. *Storage*

1. Type (Tank, Rock Bed, etc.) Tank
2. Materials
   a. Type Steel
   b. Finishes STI Corrosion Resistant Coating
   * c. Commercial Identification Kennedy Tank Co.
3. Physical Dimensions: 10,000 Gal., 1337 FT^3
   a. Height 8'-0" Diameter
   b. Width -
   c. Length 27'-5"
4. Thermal Properties*
   a. Thermal Conductivity See Mark's Handbook
   b. Coefficient of Thermal expansion See Mark's Handbook
5. Operating Temperature Range 75-212 °F
6. Operating Pressure Range* 0 - 15 PSI
7. Burst Pressure* PSI

D. *Cooling Subsystem* Not Applicable

1. Type
2. Commercial Unit
   a. Type
   b. Size TONS
   c. Identification
3. Materials
   a. Types
   b. Commercial Identification

* Properties of conventional materials that are available in standard references such as Mark's Engineering Handbook need not be restated here provided the material is adequately specified so that its properties can be determined from such references. Properties of materials not commonly available in standard references should be submitted with system data to the extent known.

System and Subsystem Performance/Technical Data–Continued

4. Fluids NOT APPLICABLE

   a. Types _____

   b. Composition _____

5. Coefficient of performance (COP) data versus pertinent operating conditions (ambient temperature etc.) along with a definition of the COP used.

6. Total Cooling Capacity

   Total cooling capacity of the solar system shall be no less than _____ BTU/HR (if it is a heating and cooling system). Sensible capacity shall be no less than _____ BTU/HR at _____ CFM of entering evaporator air at _____ °F dry bulb and _____ °F wet bulb. For other systems such as desiccant cycling cooling, the terms evaporator and condensor are not applicable. These systems shall deliver the above cooling capacity at inlet air flow of _____ CFM at °F dry bulb and _____ °F wet bulb.

E. *Heating Subsystem*

1. Type Air Handling Units with Electric Resistance Coil

2. Commercial Unit

   a. Type Horizontal Draw-Thru Type AC

   b. Size 18 (18 sq. FT. coil)

   c. Commercial Identification American Air Filter

3. Coefficient of Performance (COP, if applicable, data versus pertinent operating conditions (ambient temperature etc.) N/A

4. Total Heating Capacity

   The total heating capacity of the solar system shall be no less than 580,000 BTU/HR at 28,000 CFM of air flow entering at 64 °F dry bulb and 30 % relative humidity. Exposed heated panel (baseboard or ceiling) temperatures shall not exceed N/A °F.

F. *Hot Water Subsystem* NOT APPLICABLE

1. Type _____

System and Subsystem Performance/Technical Data–Continued

2. Commercial Unit

NOT APPLICABLE

a. Type _____

b. Size _____

c. Commercial Identification _____

3. Hot Water (Back Up System) : _____ gallons of potable (of useable) hot water shall be delivered at no less than _____ gal/min at temperature no less than _____ °F. Recovery time shall be no greater than _____ hours.

4. Code and Safety Standard Certified Under _____

G. *Transport Between Subsystems*

1. Provide Sketch/Block diagram of Proposed Solar System giving dimensions and subsystems/components location and identification. See Sheet #1, Section J

2. Piping Details

a. Diameter 3" max.

b. Length of Run ~1000 FT.

c. Materials Type L Copper Tube

3. Piping Insulation

a. Type Armstrong Armaflex Above Roof
Armstrong Accotherm Below Roof

b. Thickness 1"

c. Performance K=0.23 BTU/HR. Sq.Ft. (F deg/in.)

4. Transport Media for each element

a. Type Water/Ethylene Glycol Solution

b. Flow Rate Max. 1.0 GPM (Liquid) N/A CFM (Air)

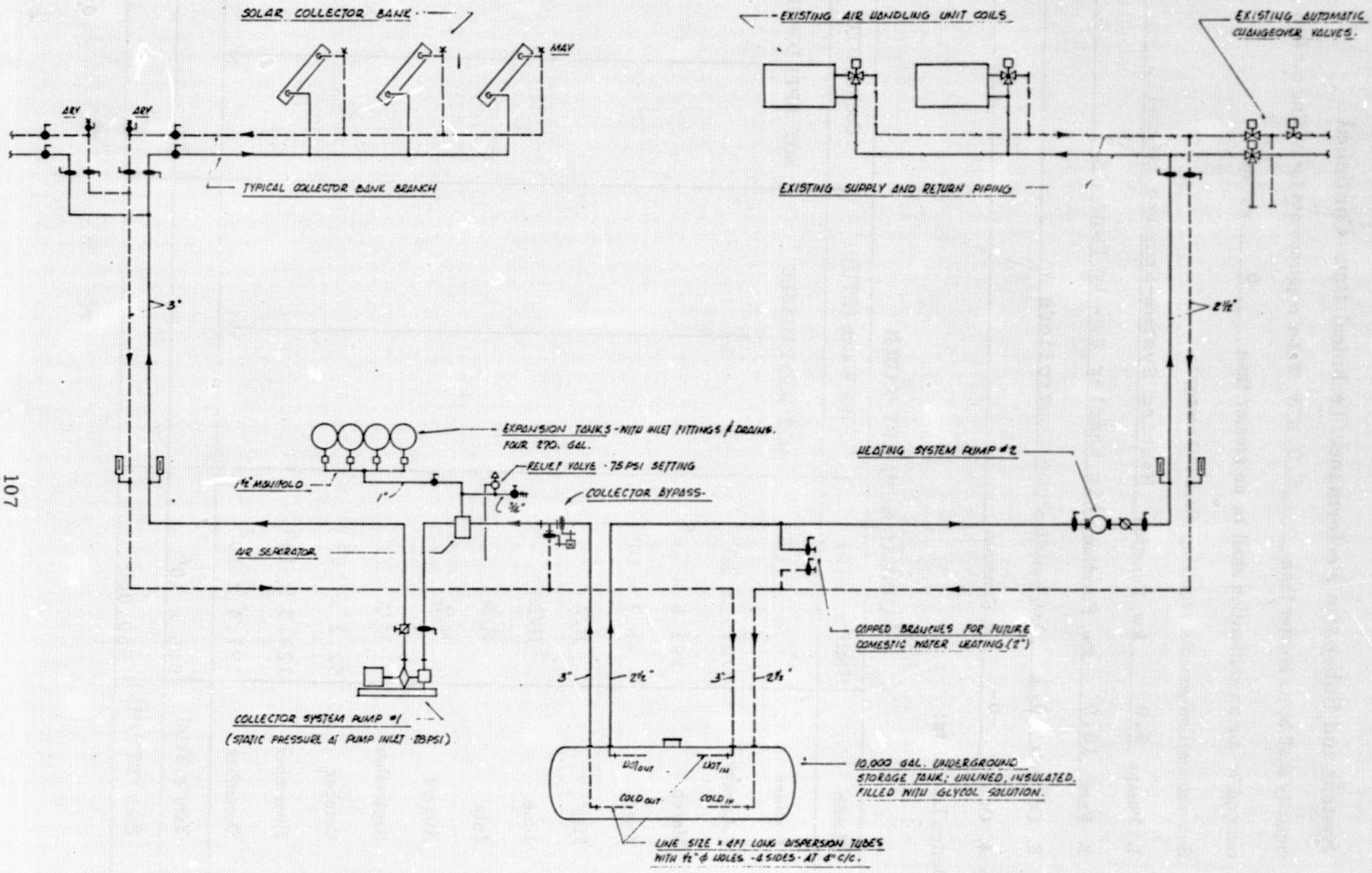
c. Specify Pressure drop between components. Collector ΔP = 1.5 PSI

5. Provide Flow diagram for Proposed Solar Energy System. See following page.

H. *System*

1. Operating Requirements

a. The maximum electrical energy required to drive the solar portion of the system at its rated



SCHEMATIC PIPING DIAGRAM

NO SCALE

System and Subsystem Performance/Technical Data–Continued

capacity shall be no greater than 6.0 K.W. Water requirements for cooling condensers and/or air humidification shall be no greater than 0 gal/hr.

b. Subsystems/Components requiring electrical energy:

1. Pumps 6.0 kw, Function Heating System-Storage to Coils
2. Fans 18.0 kw, Function Air Handler Supply Fans (8)
3. Controls 0.1 kw, Function Pump Controllers
4. Other -0- kw, Function

2. Design Load Data:

ANNUAL SUMMARY TABLE

Month	Heating (BTU)	Hot Water (BTU)	Cooling BTU
January	195.9×10^6	NOT APPLICABLE	NOT APPLICABLE
February	172.3×10^6		
March	143.6×10^6		
April	66.3×10^6		
May	N/A		
June	N/A		
July	N/A		
August	N/A		
September	N/A		
October	52.2×10^6		
November	128.3×10^6		
December	187.4×10^6		
Yearly Total	946×10^6		
Peak (BTU/HR)	580,000		

System and Subsystem Performance/Technical Data–Continued

3. Provide the following summary of system performance data:

Month	Solar Energy Collected (BTU)	Electrical Energy Req'd for Component (BTU)	Auxiliary Energy (BTU)	System Heat Loss (BTU)	Equivalent Energy Req'd for Conventional System (BTU)
January	66.7×10^6	37×10^6	129.2×10^6	9.8×10^6	195.9×10^6
February	81.6×10^6	37×10^6	90.7×10^6	8.6×10^6	172.3×10^6
March	136.9×10^6	37×10^6	6.7×10^6	7.2×10^6	143.6×10^6
April	120.7×10^6	37×10^6	-	3.3×10^6	66.3×10^6
May	N/A				
June	N/A				
July	N/A				
August	N/A				
September	N/A				
October	140.7×10^6	37×10^6	-	2.6×10^6	52.3×10^6
November	87.9×10^6	37×10^6	40.4×10^6	6.4×10^6	128.3×10^6
December	59.4×10^6	37×10^6	128.1×10^6	9.4×10^6	187.5×10^6

4. Provide estimate of yearly energy savings in terms of BTU's and/or Dollars along with the rationale for the estimate.

5. Any subsystems or system energy conversion inefficiencies which have not been specified in the previous subsystem section should be provided now. For example, if an oil fired heater is used for an auxiliary energy source state its:

1. Commercial identification NOT APPLICABLE
2. Size/Rating (BTU)
3. Efficiency
4. Electrical Power Requirements

6. Provide summary of insolation data used for section H Analysis.

System and Subsystem Performance/Technical Data–Continued

7. Design Life and Maintenance

   a. Describe Periodic Maintenance provisions and requirements. See Section H

   b. Specify design life of all components (if available).

   1. Heating 15 yrs.
   2. Cooling N/A yrs.
   3. Auxiliary Energy 15 yrs.
   4. Storage 20 yrs.
   5. Potable N/A yrs.
   6. Collector 15 yrs.
   7. Energy Transport 20 yrs.
   8. Controls 10 yrs.
   9. Hot Water N/A yrs.
   10. Pumps 20 yrs.
   11. Fans 15 yrs.
   12. Other N/A yrs.

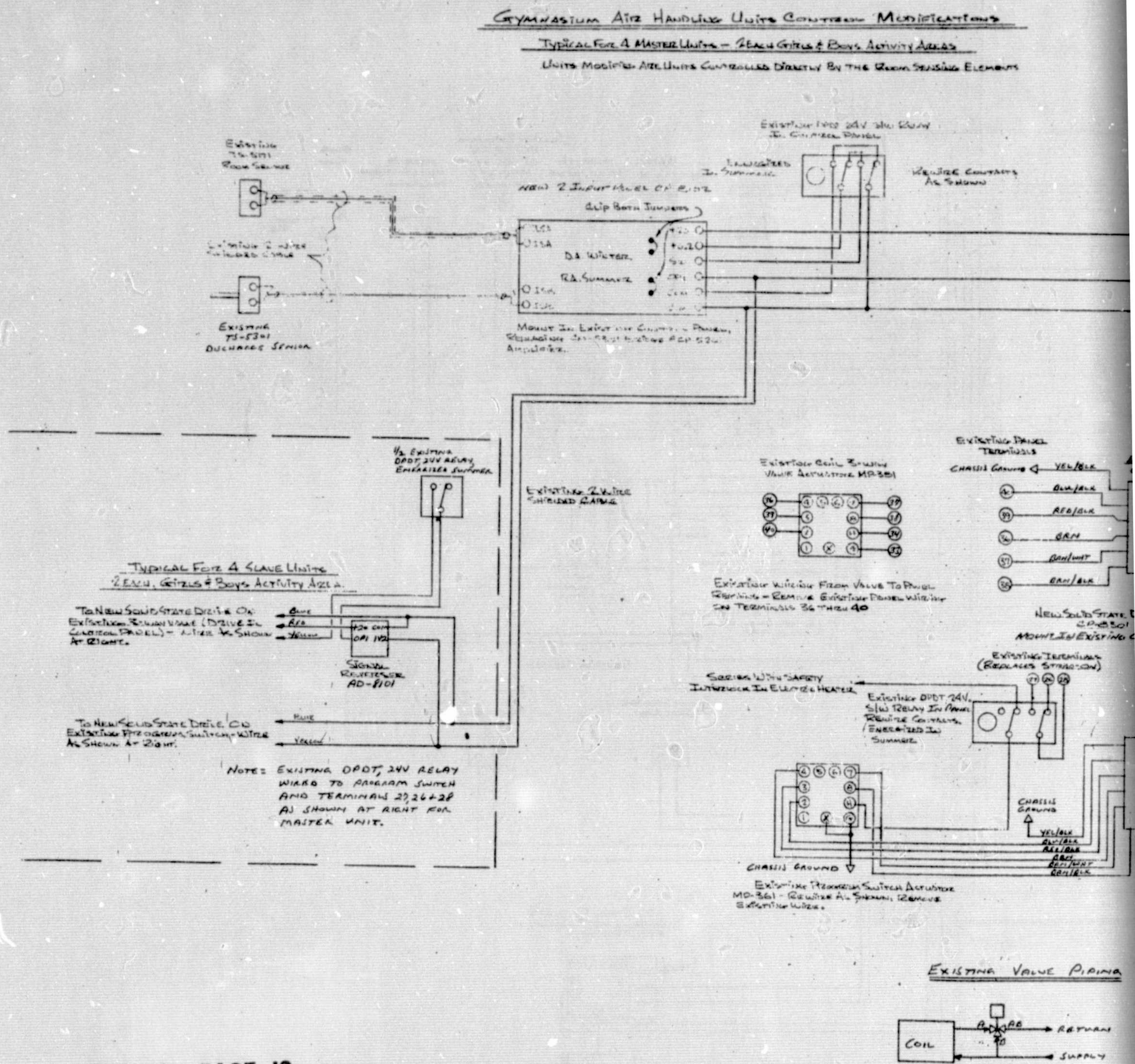
   c. Provide Warranty period and extent of coverage of the proposed Solar Energy System and subsystems.

Construction contract will provide for standard one year warranty on all aspects of new construction.

APPENDIX E

AS-BUILT DRAWINGS

Gymnasium Air Handling Units Control Modification	Drawing 77-342-1
New Control Panel	Drawing 77-342-2
Roof Structural Framing Plan	Job No. 776C, Sh. 1
Roof Plan-Collector Installation and Piping	Job No. 776C, Sh. 2
Basements and Partial First Floor Plan	Job No. 776C, Sh. 3
Schematic Piping Diagram and Expansion Tank Detail	Job No. 776C, Sh. 4



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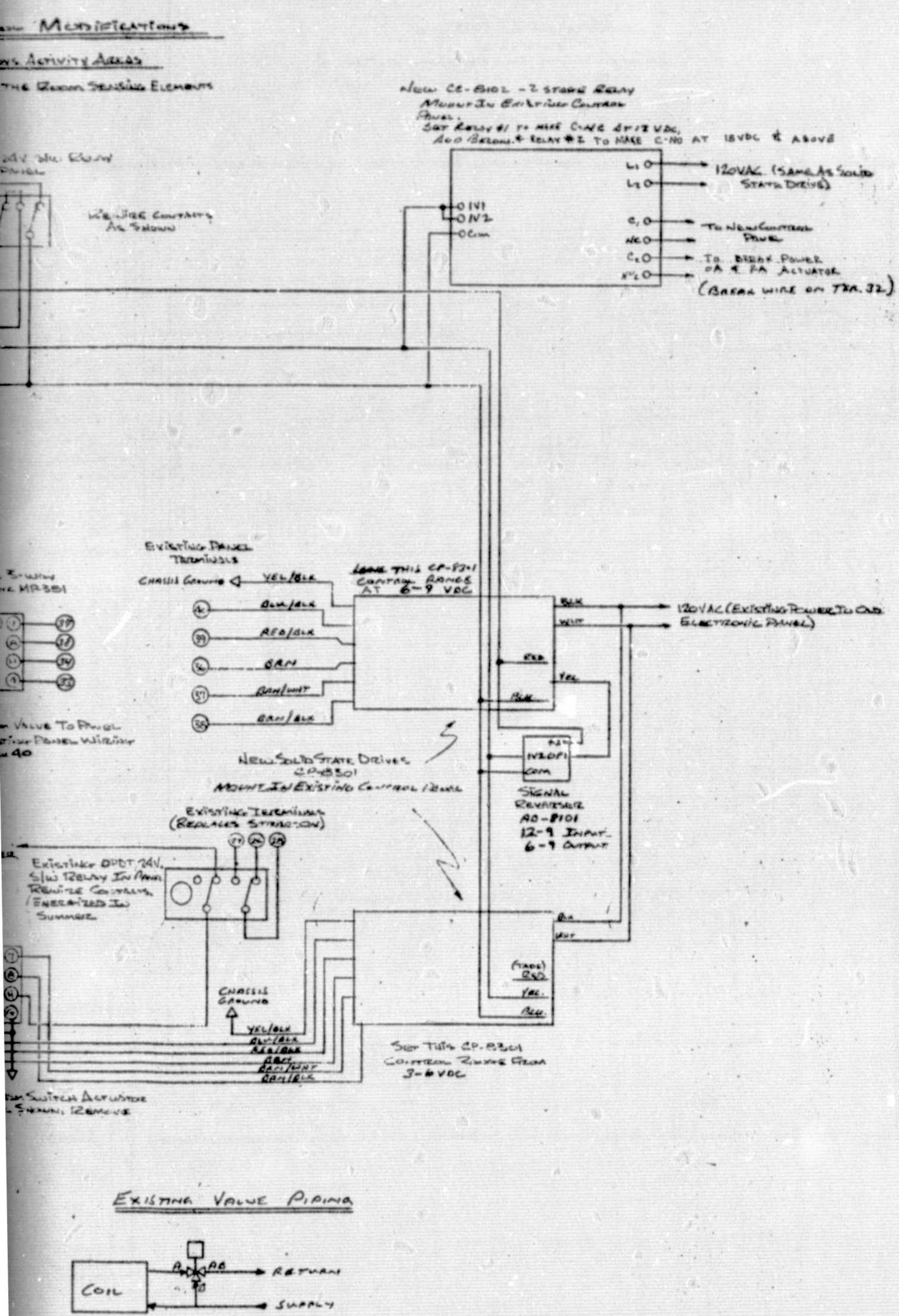


SEQUENCE OF OPERATION

The temperature control panel contains a differential temperature control system with a sensing element located near the top of a typical solar collector which will sense radiation temperature under the glazed surface, and the comparison thermostatic element located in the bottom of the water storage tank. Whenever the collector surface temperature is 15° greater (adjustable) than tank temperature, the solar collector circulating pump (#1) [redacted] will cycle on and run continuously until this differential temperature has dropped approximately 7° (adjustable). This will assure that the system will collect heat while the sun is shining on the surface of the collector but will not dissipate heat when a collector is not exposed to insolation.

The heating system circulating pump (#2) [redacted] controlled by a master/submaster temperature controller. The pump will operate on demand of either of the two (2) gymnasium room thermostats providing the storage water temperature is above 80°F (adjustable). This will be accomplished as follows: The existing room sensor, through a new solid state panel, will proportion the existing 3-way valve on the coil and the existing electric heat program switch in sequence, with the electric heat being energized only if solar heat is not sufficient. The coil valve and program switch are sequenced through new solid state drives driven by the new solid state panel. A new solid state relay, also driven by the panel will energize the solar heating system.

If the air handler heat output is insufficient while operating in the solar heated water coil, the existing unit electric resistance heating coils will be staged to satisfy demands of the room thermostats.

A switch is provided on the control panel door marked "Solar Heating System"-"Automatic-Off". This switch should be left in the automatic position during the heating season.

The face of the control panel has pilot lights to indicate when each of the room thermostats are calling for heat. Also mounted on the face of the control panel are solid state thermometers indicating temperature of glycol solution near the top of typical solar collector and the temperature near the top and the bottom of the storage tank.

The eight existing gymnasium air handlers (4 ea. gym) have their control cycles modified to change the minimum setting of the outdoor air dampers from 25% outdoor air to 10% outdoor air.

Alternate #2: A collector bypass system will prevent return water from the collectors from entering the storage tank until the return water temperature is equal to or greater than the temperature of the water stored in the top of the tank, by proportioning a 3-way butterfly valve as required.

To protect collector system when pump is ordinarily not in operation, the collector circulating pump (#1) will cycle on and run continuously whenever the collector surface temperature is above 275°F, as sensed by a bulb thermostat.

An alarm and pump cut-off system will be activated upon loss of system pressure. Upon loss of system pressure, BOTH PUMPS will immediately be de-energized and an alarm light on the control panel and an alarm horn will be activated. The alarm light will remain on until the low pressure situation is corrected. An alarm siren silencing switch located on the control panel door will permit the horn to be silenced while the low pressure situation is corrected.

FOLDOUT FRAME 2

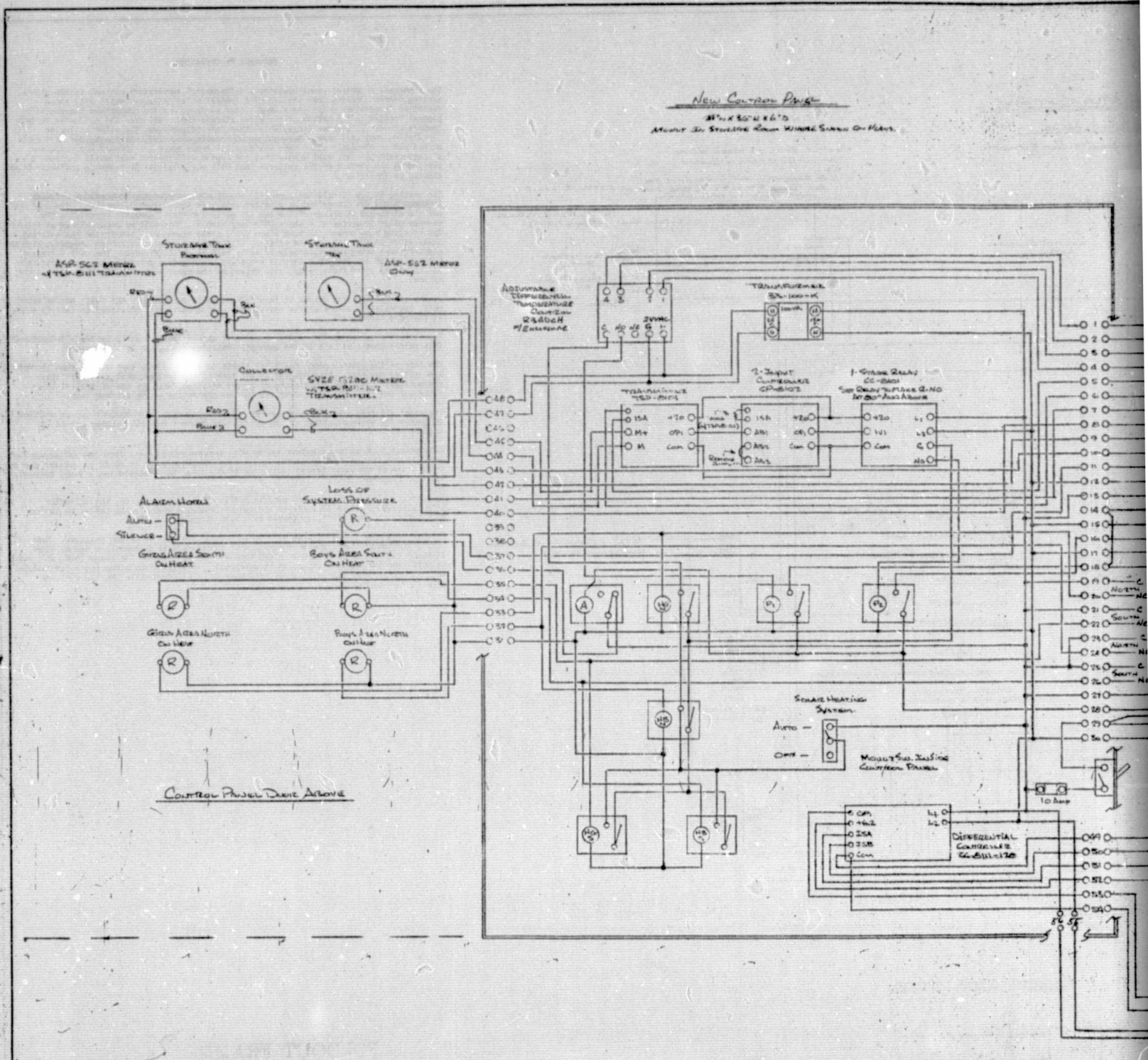
AS-BUILT DRAWING

RADEMAKER Corp.

Clarksville Middle School Solar Energy Retrofit — Scale: None

Location: Clarksville, Indiana

Date: 11/18/77 — Approved by: Harry S. Sladen — Drawing number: 77-342-1



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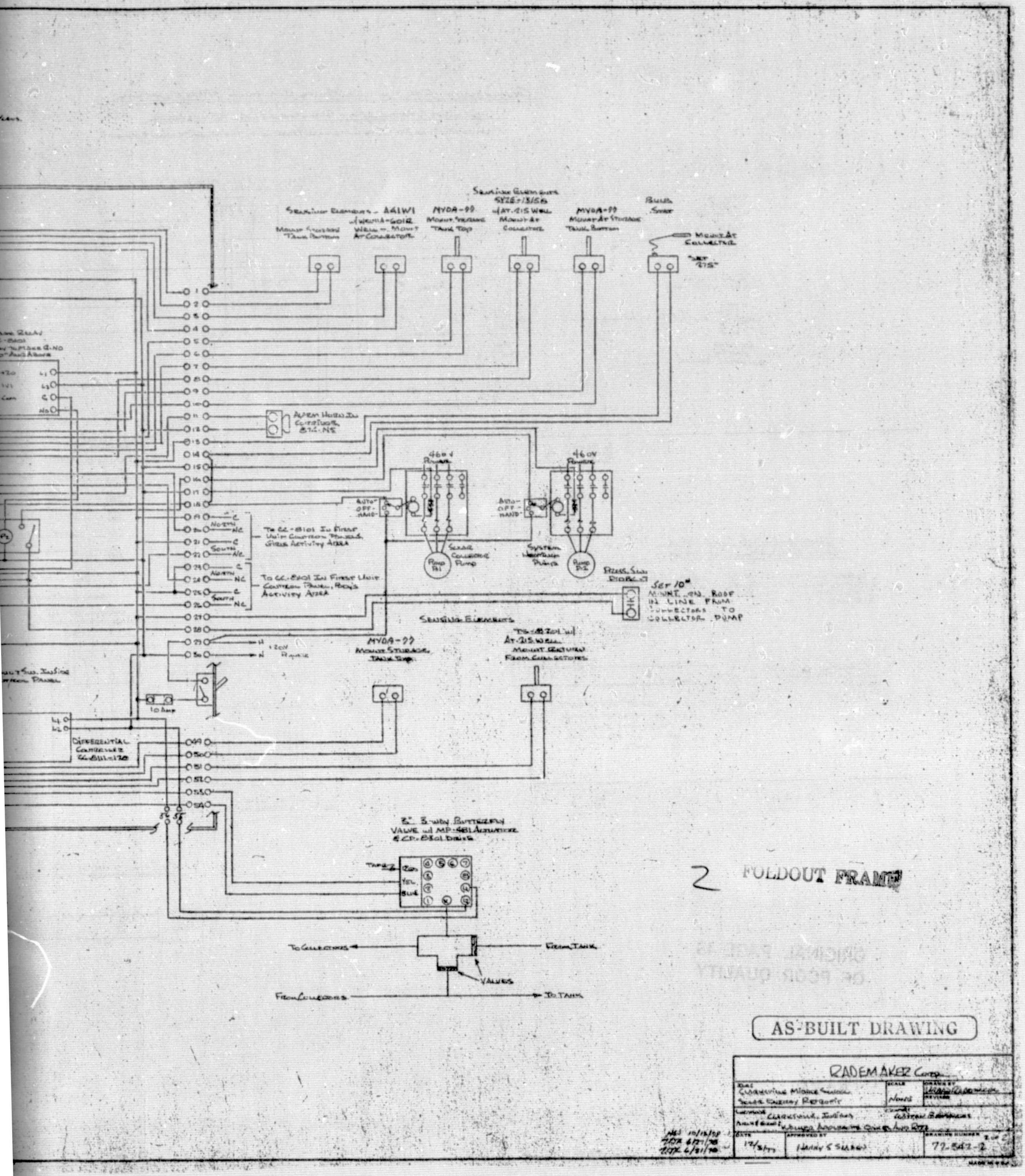
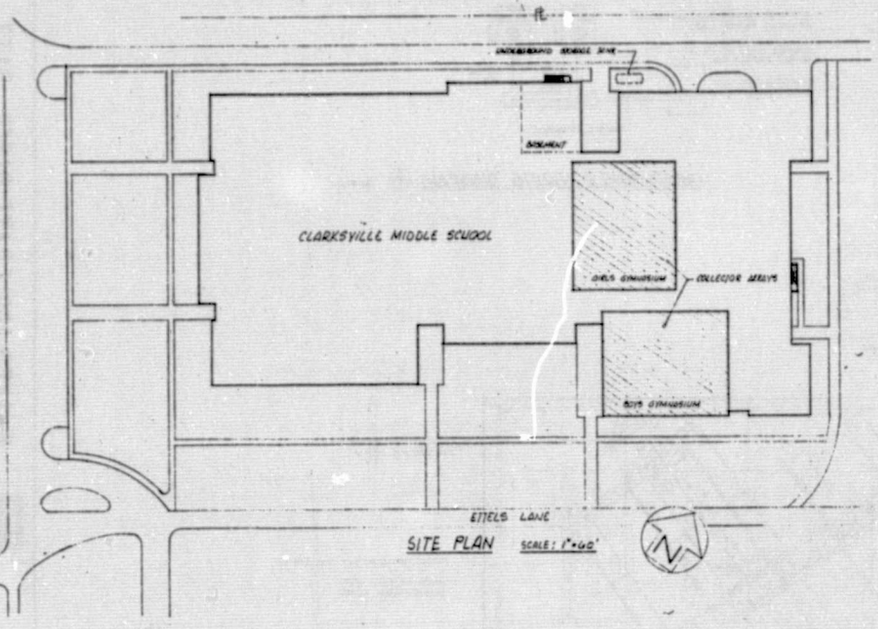
FOLDOUT FRAME 1

K+E CRYSTALENE © 16 5472
ARCHITECTS STANDARD FORM



MYDA-99
Sensing Elements
460V Power
Solar Collector Pump
System Heating Pump
Differential Controller
To Collectors
From Tank
From Collectors
To Tank
Values
2 FOLDOUT FRAME
AS-BUILT DRAWING
RADEMAKER Corp.
Clarksville Middle School
Solar Energy Retrofit
Clarksville, Indiana
None
77-542-2

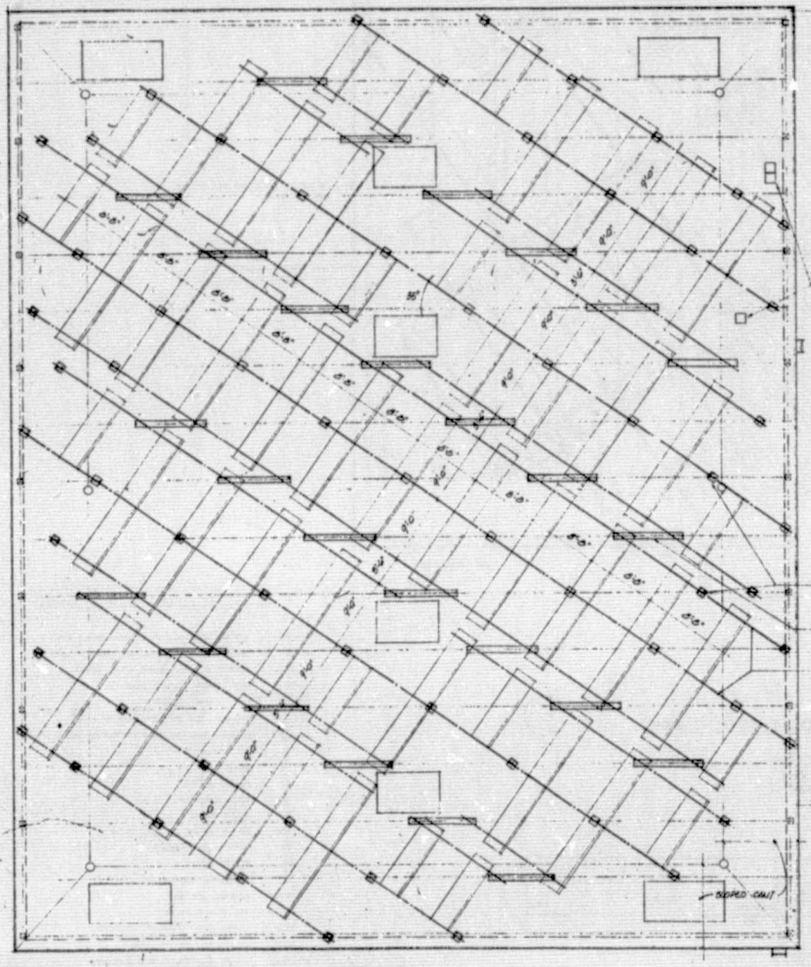
G F E D



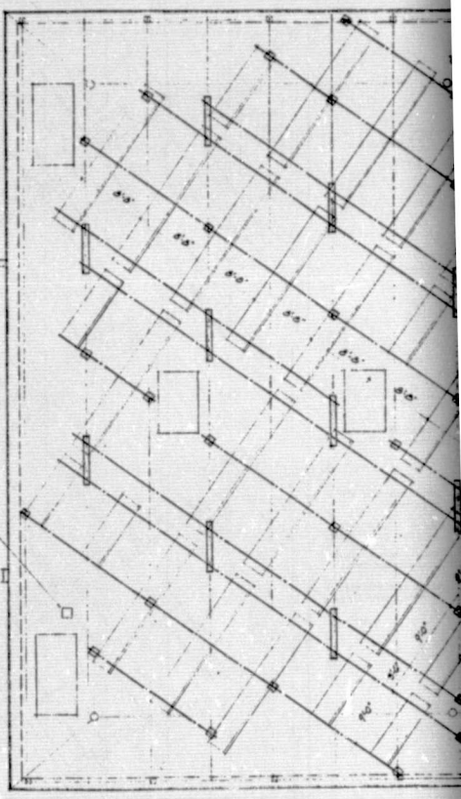
SITE PLAN SCALE: 1"=60'

GENERAL NOTES

1. HEIGHT OF 12" SQUARE EQUIPMENT RAILS CREATED SUPPORT BEAM LEVEL.
2. CONTRACTOR SHALL TAKE ALL PRECAUTIONS NECE... AND SHALL PROVIDE TEMPORARY PROTECTIVE S... MEMBERS DURING CONSTRUCTION.
3. OPENINGS CUT THROUGH EXISTING ROOF MEMBRA... ROOFING SYSTEMS) SHALL BE KEPT WATER TIGHT ... PERMANENT WATERTIGHT CONSTRUCTION IS COMPLETE...
4. CONTRACTOR IS CAUTIONED THAT CALCIUM CHLORI...
5. STRUCTURAL BEAMS TO FOLLOW GENERAL CON...

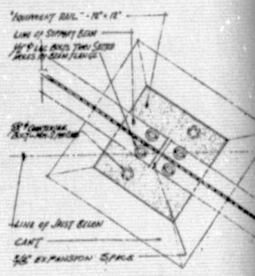


BOYS GYMNASIUM



GIRLS GYM...

ROOF STRUCTURAL FRA...



EQUIPMENT SUPPO...

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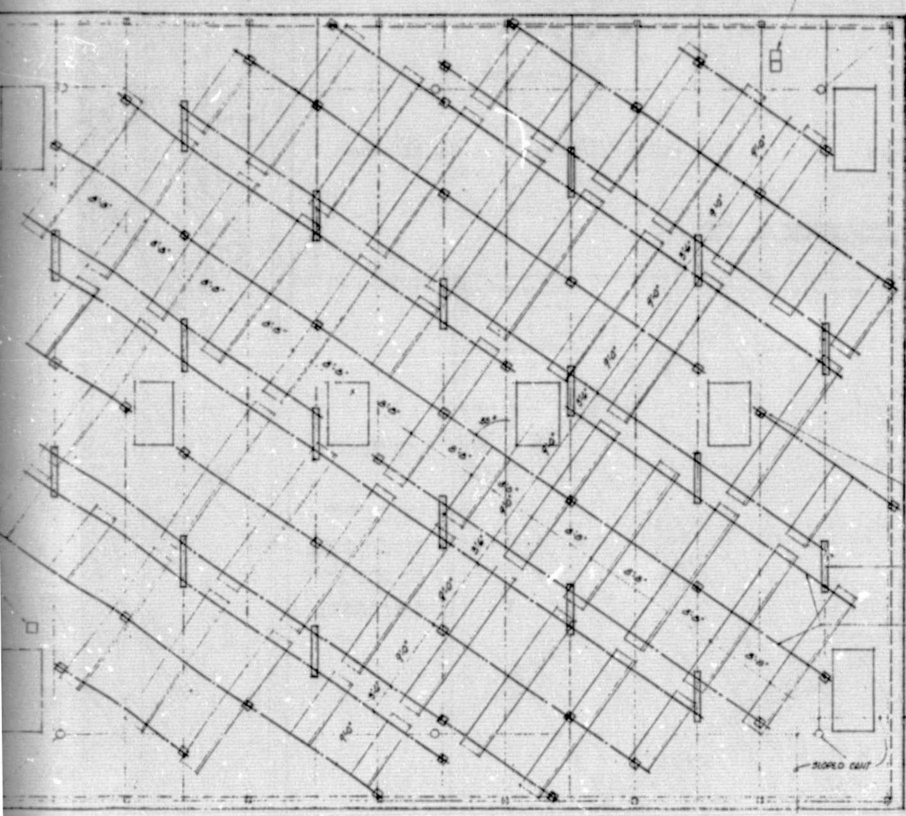
OF POOR QUALITY

FOLDOUT FRAME

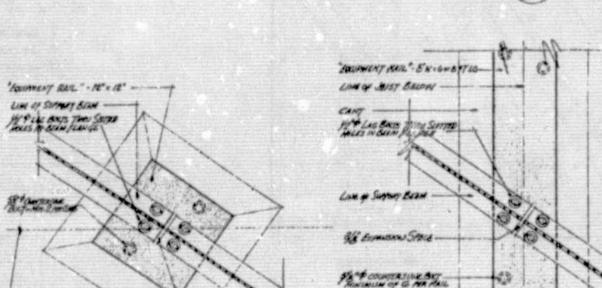
GENERAL NOTES

1. HEIGHT OF 12" SQUARE EQUIPMENT RAILS LOCATED IN SLOPED CANT AREA TO BE AS REQUIRED TO INSTALL SUPPORT BEAM LEVEL.
2. CONTRACTOR SHALL TAKE ALL PRECAUTIONS NECESSARY TO MAINTAIN ROOF IN PRESENT WATER TIGHT CONDITION AND SHALL PROVIDE TEMPORARY PROTECTIVE SURFACES AND/OR OTHER DEVICES NECESSARY TO PROTECT ROOFING MEMBRANE DURING CONSTRUCTION.
3. OPENINGS CUT THROUGH EXISTING ROOF MEMBRANE (REQUIRED FOR INSTALLATION OF NEW STRUCTURAL AND PIPING SYSTEMS) SHALL BE KEPT WATER TIGHT BY SUITABLE TEMPORARY FLASHINGS AND CEMENT UNTIL PERMANENT WATERTIGHT CONSTRUCTION IS COMPLETE.
4. CONTRACTOR IS CAUTIONED THAT GLYCOL SOLUTION IS HARMFUL TO ROOFING MATERIALS.
5. STRUCTURAL BEAMS TO FOLLOW GENERAL CONTOUR OF ROOF. LEVEL COLLECTORS ON BEAMS.

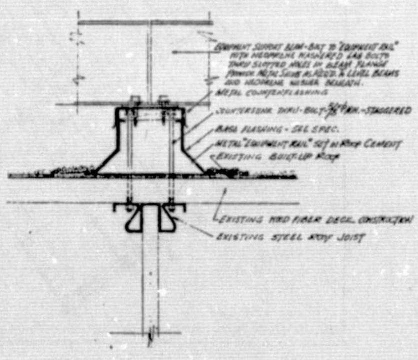


FOLDOUT FRAME 2

ROOF STRUCTURAL FRAMING PLAN 1/8"=1'-0"



EQUIPMENT SUPPORT PLANS 1/2"=1'-0"



TYPICAL EQUIPMENT SUPPORT DETAIL 1/2"=1'-0"

MAY 1, 1979

WALKER APPLEGATE OAKES - RITZ
AIA ARCHITECTS
NEW ALBANY INDIANA

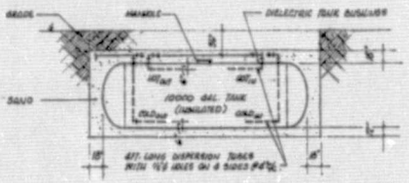
SOLAR ENERGY RETROFIT
FOR
CLARKSVILLE MIDDLE SCHOOL
CLARKSVILLE INDIANA

Job Number 776C

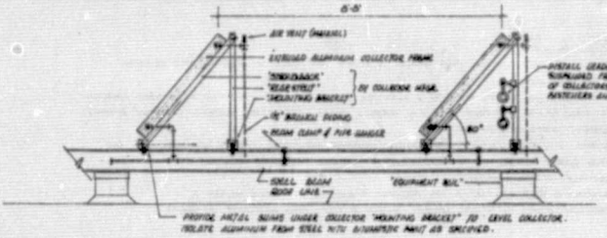
Sheet 1

Of 4 Sheets

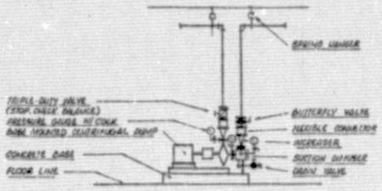
G F E D



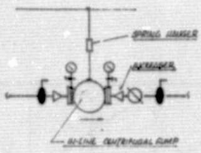
TANK INSTALLATION DETAIL ⊕ 1/8"=1'-0"



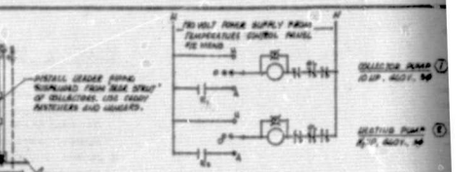
COLLECTOR INSTALLATION DETAIL ⊕ 1/2"=1'-0"



PUMP INSTALLATION DETAIL ⊕ NO SCALE

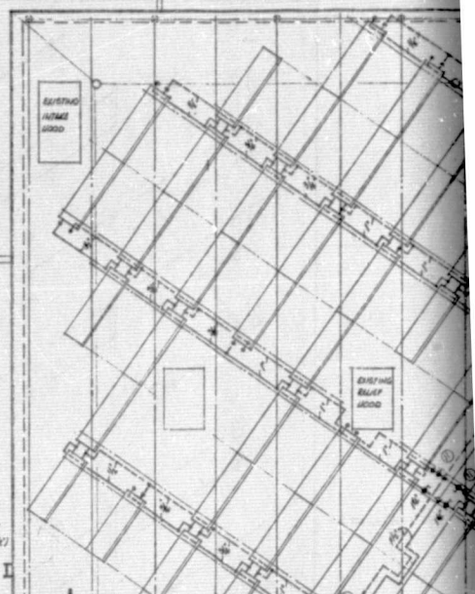


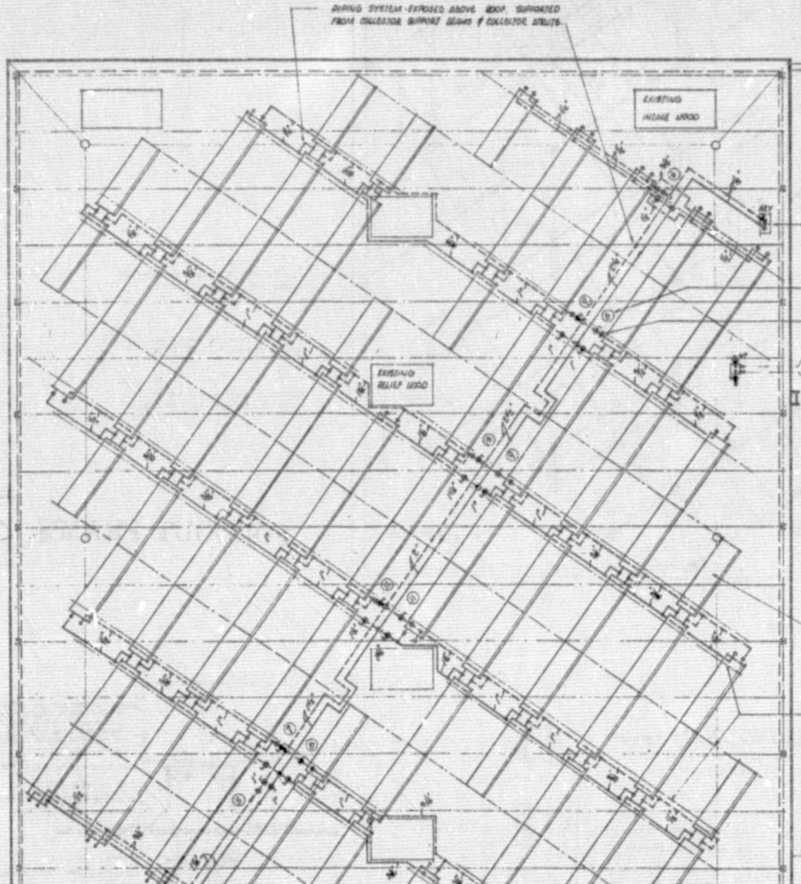
PUMP INSTALLATION DETAIL ⊕ NO SCALE



D1 - RELAY IN TEMP. CONTROL PANEL OPERATED BY DIFFERENTIAL
D2 - RELAY IN TEMP. CONTROL PANEL OPERATED BY HIGH TEMP

PUMP STARTER WIRING DIAGRAM





83 COLLECTORS

ROOF PLAN - COLLECTOR INSTALLATION AND

1. GRADE PIPING UP IN DIRECTION OF FLOW TO PROVIDE PROPER VENTING AND DRAIN
2. AIR RELIEF VALVES TO BE INSTALLED WITH 6" LONG x [illegible] NIPPLE AND BALL OFF
3. REMOVE HANDLES FROM ALL BALL VALVES ON ROOF AFTER BALANCING IS COMPLE

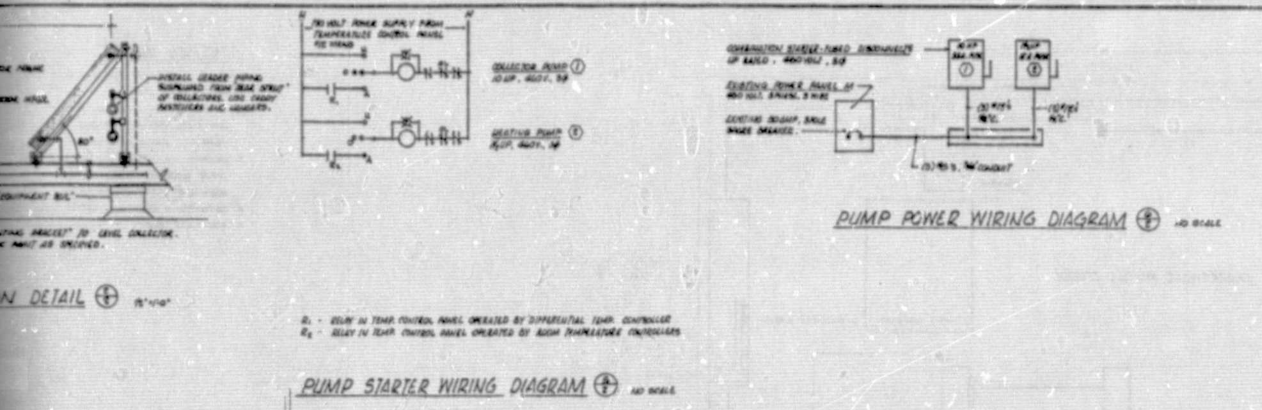
SOLAR COLLECTOR SCHEDULE

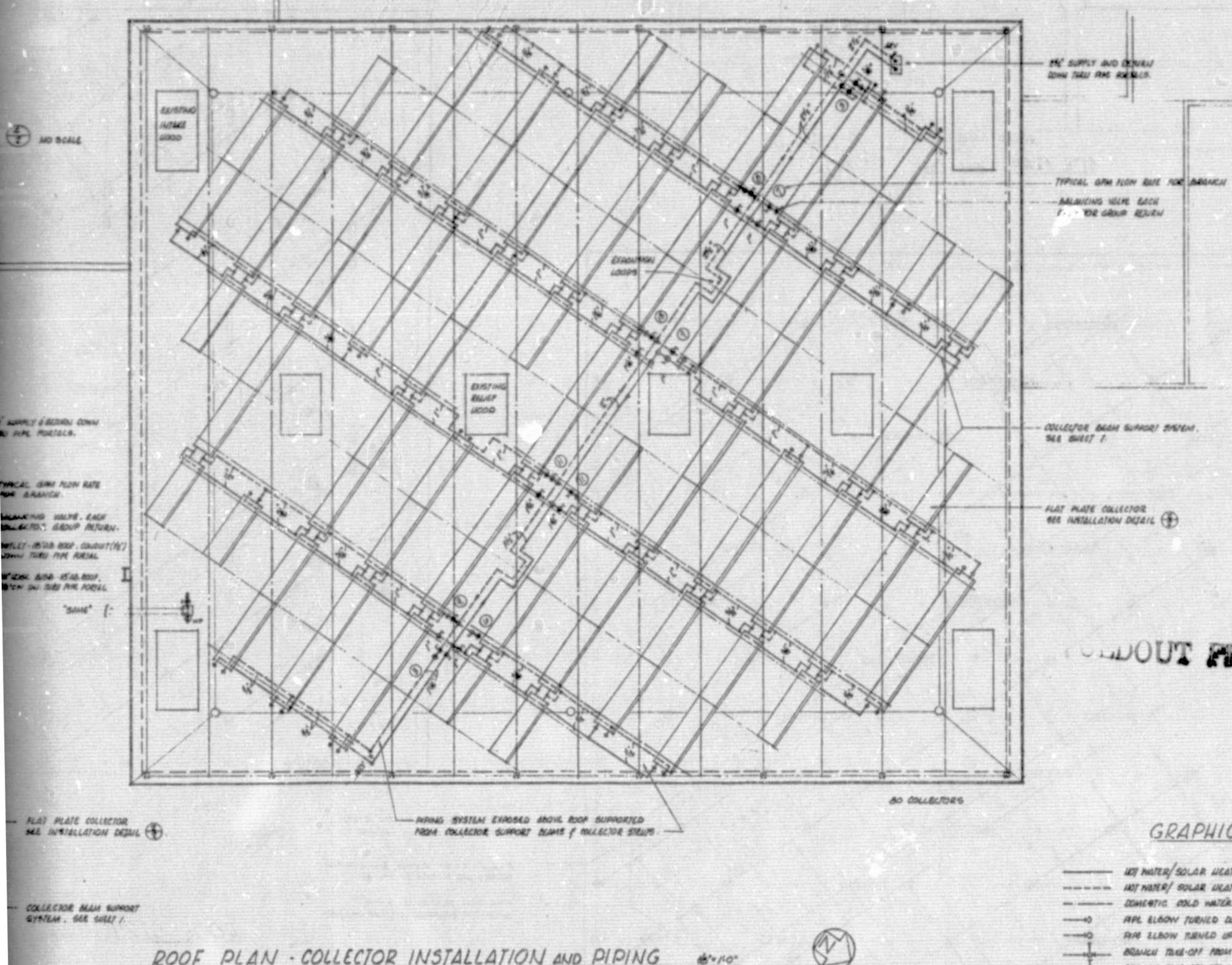
TYPE	SIZE	FLOW RATE GPM	TILT ANGLE	ROW O/C SPACING	SHADOW ANGLE	ROW ARRANGEMENT	PIPING CONFIGURATION SUPPLY	RETURN	
FLAT PLATE	6'10"x8'0"	1.0	30°	6'-8"	47°	SERPENTINE	BOTTOM	TOP	

CIRCULATING PUMP SCHE

MARK	TYPE	GPM	HEAD FT. H2O	HP	RPM	SUCTION IN.	DISCHG. IN.	REMARKS
(1)	BASE MTD.	189	101	10	3500	6"	5"	COLLECTOR PU
(2)	IN-LINE	70	35	1/4	1750	2"	2"	HEATING PUMP

FOLDOUT FRAME 1





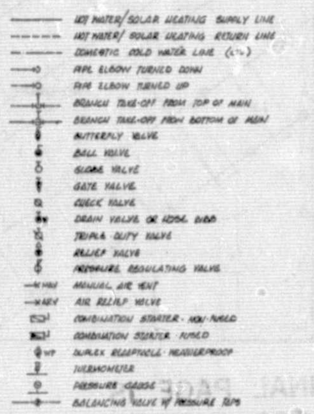
1. GRADE PIPING UP IN DIRECTION OF FLOW TO PROVIDE PROPER VENTING AND DRAINING
2. AIR RELIEF VALVES TO BE INSTALLED WITH 6" LONG × ¾"Ø NIPPLE AND SHUT-OFF VALVE.
3. REMOVE HANDLES FROM ALL BALL VALVES ON ROOF AFTER BALANCING IS COMPLETE.

SOLAR COLLECTOR SCHEDULE

TYPE	SIZE	FLOW RATE GPM	TILT ANGLE	ROW OF SPACING	SHADOW ANGLE	FLOW ARRANGEMENT	PIPING CONNECTIONS SUPPLY	RETURN	SIZE	NUMBER REQUIRED	REMARKS
FLAT PLATE	10'0"×4'0"	1.0	50°	8'8"	27°	SERPENTINE	SIDE, BOTTOM	SIDE, TOP	¾"	165	DOUBLE GLAZED

CIRCULATING PUMP SCHEDULE

MARK	TYPE	GPM	HEAD FT. H2O	HP	RPM	SUCTION IN.	DISCHG. IN.	REMARKS	ELECTRICAL CHARACTERISTICS VOLTS, PHASE, HZ.
1	BASE MTD.	189	101	10	3500	3"	2½"	COLLECTOR PUMP	460-3-60
2	IN-LINE	70	35	1½	1760	2"	2"	HEATING PUMP	460-3-60



FOLDOUT FRAME 2

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AS-BUILT DRAWING
MAY 1, 1979

WALKER APPLEGATE OAKES - RITZ
AIA ARCHITECTS
NEW ALBANY INDIANA

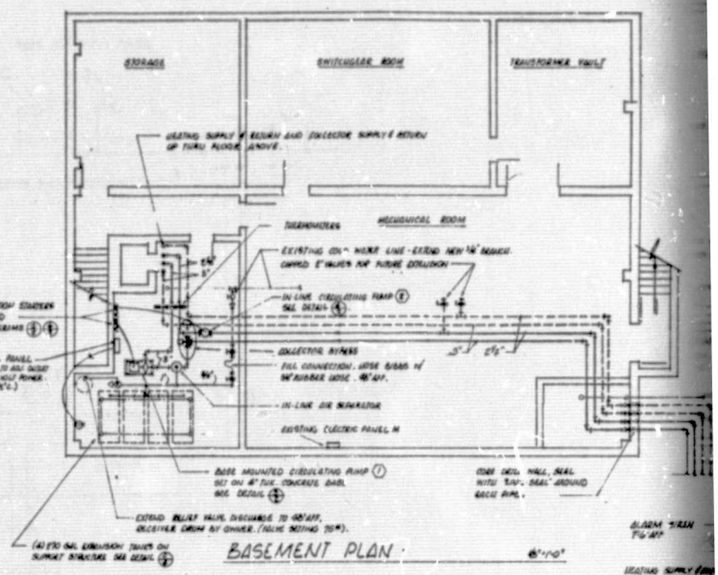
SOLAR ENERGY RETROFIT FOR CLARKSVILLE MIDDLE SCHOOL
CLARKSVILLE INDIANA

DATE: NOVEMBER 10, 1977
DRAWN: J.W. GALBREATH
REVISION A: JAN 18, 1978

JAMES W. GALBREATH REGISTERED PROFESSIONAL ENGINEER No. 10140 STATE OF INDIANA

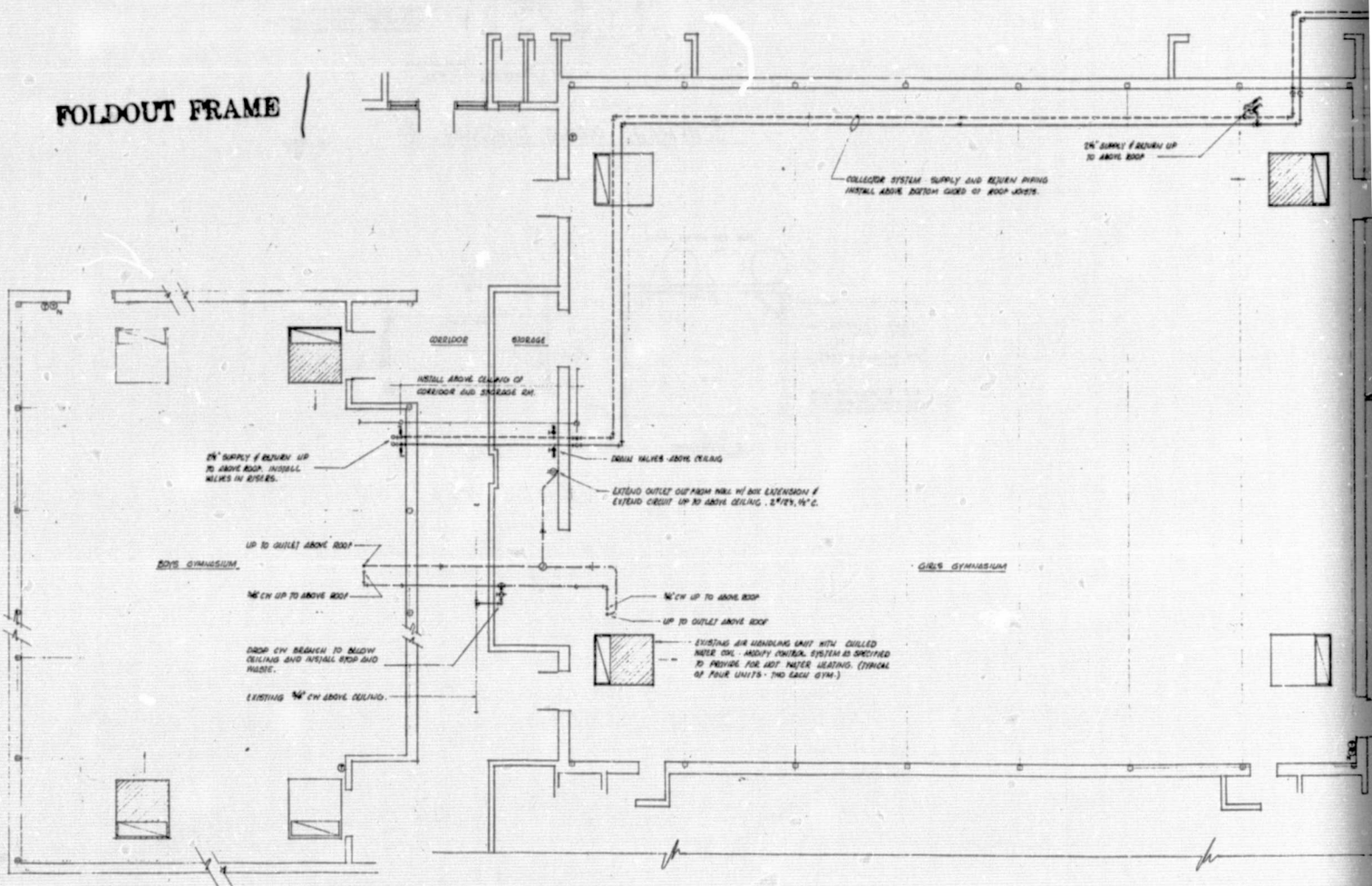
JOB NUMBER 776C
SHEET 2 OF 4 SHEETS

G F E D

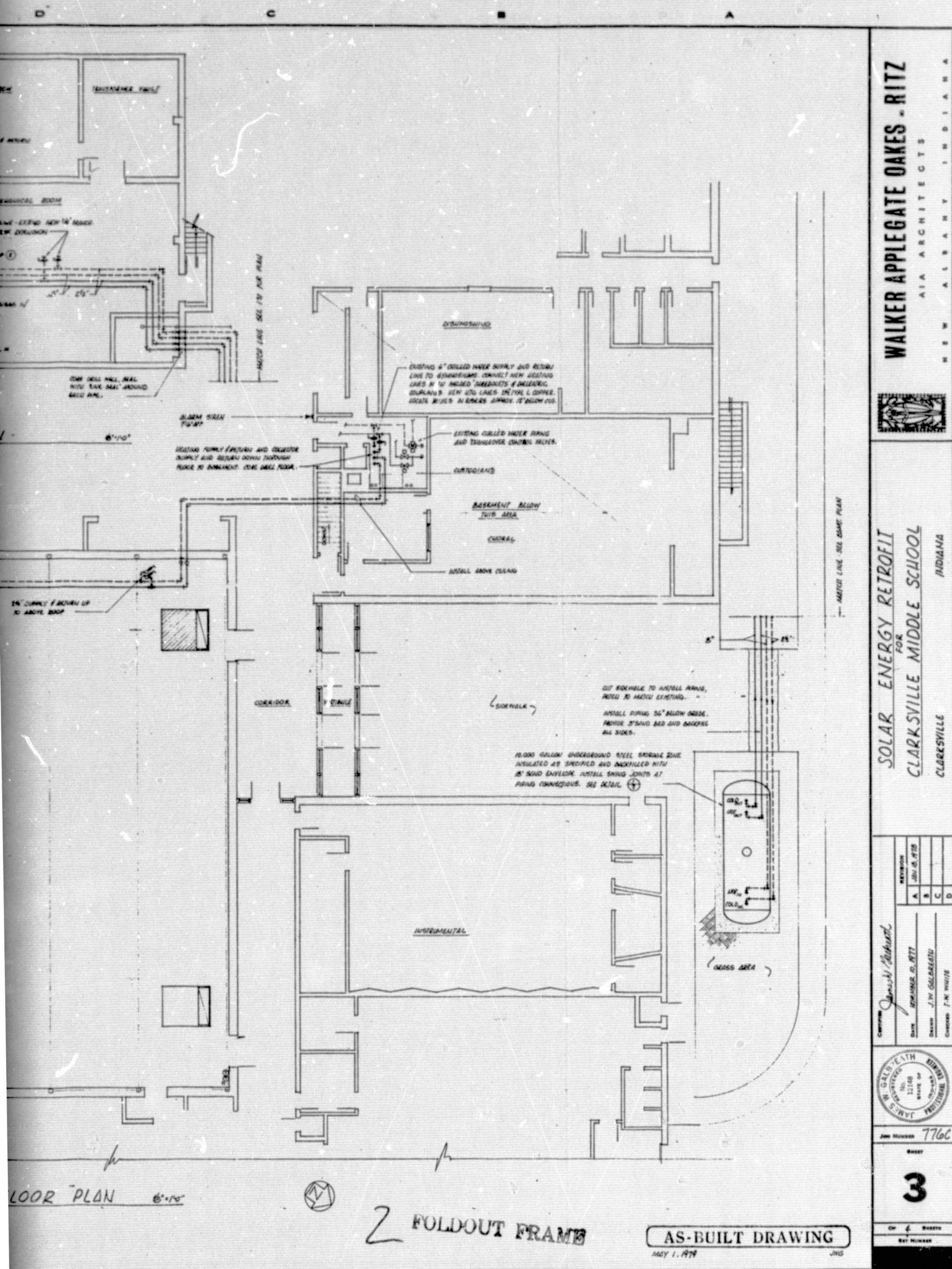


BASEMENT PLAN 8'-1"0"

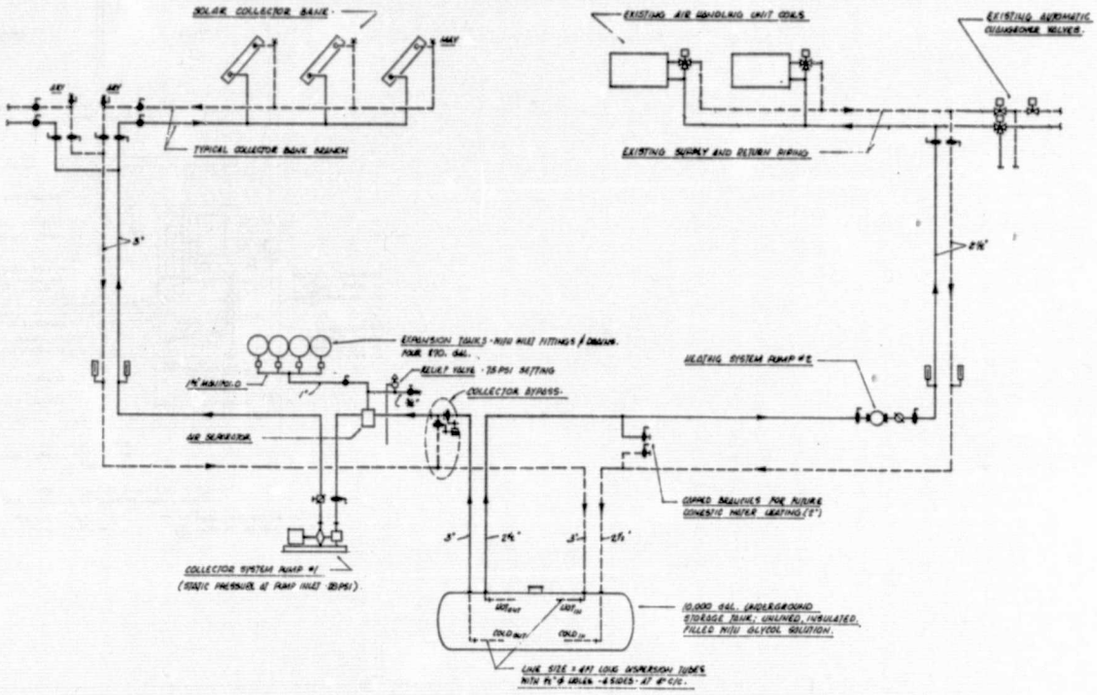
FOLDOUT FRAME



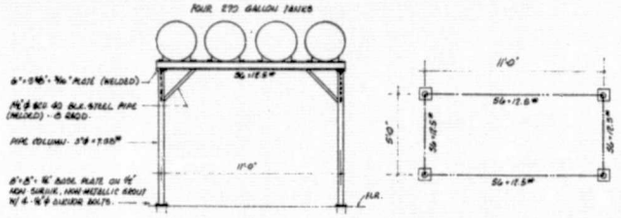
PARTIAL FIRST FLOOR PLAN 8'-1"0"



WALKER APPLEGATE OAKES & RITZ
AIA ARCHITECTS
NEW ALBANY INDIANA
SOLAR ENERGY RETROFIT
FOR
CLARKSVILLE MIDDLE SCHOOL
CLARKSVILLE
INDIANA
JOB NUMBER 776C
SHEET
3
OF 4 SHEETS
DISHWASHING
CUSTODIANS
BASEMENT BELOW
CHORAL
CORRIDOR
INSTRUMENTAL
MATCH LINE - SEE BSMT. PLAN
FLOOR PLAN 6'-10"
FOLDOUT FRAME
AS-BUILT DRAWING



SCHEMATIC PIPING DIAGRAM (A/4) NO SCALE



ELEVATION PLAN

EXPANSION TANK DETAIL (A/4) 1/4"=1'-0"

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AS-BUILT DRAWING
MAY 1, 1979 JWG

WALKER APPLEGATE OAKES - RITZ
AIA ARCHITECTS
NEW ALBANY INDIANA

SOLAR ENERGY RETROFIT FOR CLARKSVILLE MIDDLE SCHOOL
CLARKSVILLE INDIANA

Designed James W Walker
Date NOVEMBER 10, 1977
Drawn J W GARRISON
Checked J W WALTZ

REVISION	
A	JAN 15, 1978
B	
C	
D	

Job Number 776 C
Sheet 4
Of 4 Sheets
Key Number